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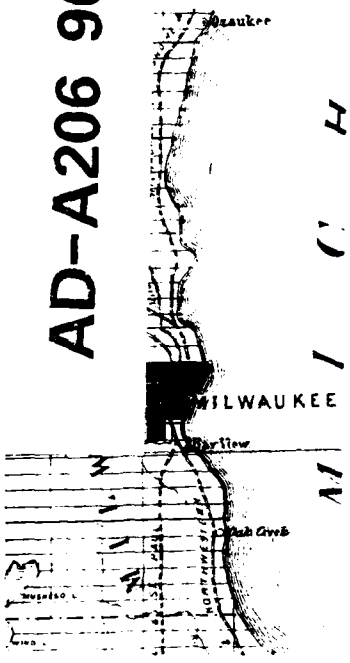
US Army Corps of Engineers



PROCEEDINGS OF THE 49TH MEETING OF THE COASTAL ENGINEERING RESEARCH BOARD

18-20 May 1988

OCONOMOWOC, WISCONSIN

Hosted by

US Army Engineer Division, North Central
and
US Army Engineer District, Detroit

February 1989
Final Report

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These proceedings provide summaries of the papers presented at the semiannual meeting of the Coastal Engineering Research Board (CERB). Also included are discussions of CERB business, recommendations for research and development by CERB members, and public comment.

→ Page 4 →

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PREFACE

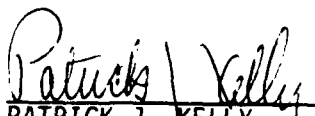
The Proceedings of the 49th meeting of the Coastal Engineering Research Board (CERB) were prepared for the Office, Chief of Engineers (OCE), by the Coastal Engineering Research Center (CERC), of the US Army Engineer Waterways Experiment Station (WES). These proceedings provide a record of the papers presented, the questions and comments in response to them, and the interaction among program participants and the CERB.

The meeting was hosted by the US Army Engineer Division, North Central (NCD), under the direction of BG Theodore Vander Els, Commander, and the US Army Engineer District, Detroit (NCE), under the direction of COL Robert F. Harris, Commander.

Acknowledgements are extended to the following: Mr. Zane M. Goodwin and Mr. David A. Roellig, NCD, Mr. Roger L. Gauthier and Mr. David L. Schweiger, NCE, who assisted with the coordination of the meeting; Mr. Ronald L. Erickson, Mr. Tom Deja, and Mr. Steven M. Running, NCE, who assisted with the coordination of the field trip; Mr. Larry W. Ryan, Mr. Jack C. Cox, Mr. James S. Loving, and Mr. Robert Montgomery, Warzyn Engineering, and Mr. David Kendziorski, Southeast Wisconsin Regional Planning Commission, who assisted in the field trip; Ms. Debra Benson and Ms. Sandra Watson, NCE, who provided secretarial support and assisted with registration; Mr. William Gilliam, NCE, who provided visual assistance; Mr. Dennis Rundlett, NCE, photographer; Mr. Glenn Cunningham and CPT Donald L. Gibbons, NCE, who provided logistic support; and Mr. Tim Lawonn, Audio-Visual of Milwaukee, who provided audio-visual support. Thanks are extended to guest participants: Mr. Leo Breirather, Great Lakes Coalition; Mr. Donald L. Totten, International Joint Commission; Mr. Henry Henderson, Chicago Shoreline Commission; Mr. Douglas R. Cuthbert, Environment Canada; Mr. Martin R. Jannereth, Michigan Department of Natural Resources; Mr. Norbert F. Schwartz, Federal Emergency Management Agency; Dr. Keith W. Bedford, Ohio State University; Dr. Guy A. Meadows, University of Michigan; and Dr. William L. Wood, Purdue University. Thanks are extended to Mrs. Sharon L. Hanks for coordinating and assisting in setting up the meeting and assembling information for this publication; Dr. Fred E. Camfield for preparing the draft proceedings from the transcript; Mrs. Gilda Miller for editing these proceedings; Mrs. Karen R. Wood for typing, all of whom are at WES. Thanks are also extended to Ms. Dale N. Milford, Certi-Comp Court Reporters, Inc., for taking verbatim dictation of the meeting.

The proceedings were reviewed and edited for technical accuracy by Dr. James R. Houston, Chief, CERC, and Mr. Charles C. Calhoun, Jr., Assistant Chief, CERC. COL Dwayne G. Lee, Executive Secretary of the Board and Commander and Director, WES, provided additional review.

Approved for publication in accordance with Public Law 166, 79th Congress, approved 31 July 1945, as supplemented by Public Law 172, 88th Congress, approved 7 November 1963.



PATRICK J. KELLY
Brigadier General, U.S. Army
President, Coastal Engineering Research Board

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INTRODUCTION

The 49th Meeting of the Coastal Engineering Research Board (CERB) was held at the Olympia Village in Oconomowoc, Wisconsin, on 18-20 May 1988. It was hosted by the US Army Engineer Division, North Central (NCD), under the direction of BG Theodore Vander Els, Commander, and the US Army Engineer District, Detroit (NCE), under the direction of COL Robert F. Harris, Commander.

The Beach Erosion Board (BEB), forerunner of the CERB, was formed by the Corps in 1930 to study beach erosion problems. In 1963, Public Law 88-172 dissolved the BEB by establishing the CERB as an advisory board to the Corps and designating a new organization, the Coastal Engineering Research Center (CERC), as the research arm of the Corps. The CERB functions to review programs relating to coastal engineering research and development and to recommend areas for particular emphasis or suggest new topics for study. The Board's four military and three civilian members officially meet twice a year at a particular coastal Corps District or Division to do the following:

a. Disseminate information of general interest to Corps coastal Districts and Divisions.

b. Obtain reports on coastal engineering projects in the host (local) District or Division; receive requests for research needs.

c. Provide an opportunity for State and private institutions and organizations to report on local coastal research needs, coastal studies, and new coastal engineering techniques.

d. Provide a general forum for public inquiry.

e. Provide recommendations for coastal engineering research and development.

Presentations during the 49th CERB meeting dealt with the fluctuations of the Great Lakes water levels. Documented in these proceedings are summaries of presentations made at the meeting, discussions which followed these presentations, and recommendations by the Board. A verbatim transcript is on file at CERC.

THE COASTAL ENGINEERING RESEARCH BOARD
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49TH COASTAL ENGINEERING RESEARCH BOARD MEETING

Oconomowoc, Wisconsin
18-20 May 1988

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Dr. Chiang Chung Mei
Dr. Dag Nummedal

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Mr. David L. Schweiger, CENCE-ED-L
Ms. Sandra Watson, CENCE-LO
Mr. Ronald E. Wilshaw, CENCE-ED-L

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Mr. John G. Oliver, CENPD-ED-TE

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Mr. Donald L. Totten, International Joint Commission, Schaumburg, Illinois
Dr. William L. Wood, Purdue University, West Lafayette, Indiana

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Ms. Betsy Kupperman, Office of Congressman Les Aspin, Racine, Wisconsin
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49TH MEETING OF THE COASTAL ENGINEERING RESEARCH BOARD
18-20 May 1988
Olympia Village
Oconomowoc, Wisconsin

AGENDA

THEME: Coastal Engineering Implications of Changes in the Great Lakes Water Levels

17 May

1830 - 2300	Milwaukee Brewers Baseball Game (Optional)	

18 May

0830 - 0840	Opening Remarks	BG Patrick J. Kelly
0840 - 0850	Welcome to North Central Division	BG Theodore Vander Els
0850 - 0930	Review of CERB Business	COL Dwayne G. Lee
0930 - 0945	COFFEE BREAK	
0945 - 1025	Proposed Education Program for Coastal Specialists in the Corps of Engineers	Dr. James R. Houston, CEWES-CV
1025 - 1050	Update of FY 88 Coastal Engineering R&D Program	Dr. James R. Houston, CEWES-CV
1050 - 1120	General Overview/Briefing on Field Trip	Mr. Steven M. Running, CENCE-CO-K Mr. Larry W. Ryan, Warzyn Engrg.
1120 - 1145	BREAK	
1145 - 1300	Travel by Bus to Racine (Box Lunch on Bus)	
1300 - 1400	Bus Tour/Briefing Racine Harbor	Mr. Larry W. Ryan, Warzyn Engrg. Mr. Jack C. Cox, Warzyn Engrg. Mr. James S. Loving, Warzyn Engrg.
1400 - 1600	Bus Tour from Racine to Milwaukee w/Intermittent Stops	Mr. Ronald L. Erickson, CENCE-ED-G Mr. Steven M. Running, CENCE-CO-K Mr. David Kendziorski, SE Regional Planning Commission

AGENDA (Continued)

1600 - 1730	Boat Tour of Milwaukee Harbor	Mr. Steven M. Running, CENCE-CO-K
1730	Travel to Miller Brewing Brewing Company or Return to Hotel	
1800 - 2100	Tour of Miller Brewing Company and Dinner	
19 May		
0800 - 0810	Opening Remarks	BG Patrick J. Kelly
0810 - 0850	Great Lakes Overview	Mr. Ronald E. Wilshaw, CENCE-ED-L
0850 - 0920	The Riparian Viewpoint	Mr. Leo Breirather, Great Lakes Coalition
0920 - 1000	IJC Reference - Task Force and Comprehensive Studies	Mr. Donald L. Totten, International Joint Commission
1000 - 1015	BREAK	
1015 - 1145	Problems and Actions Resulting from Fluctuating Lake Levels	Panel Mr. Kenneth H. Murdock, CENCE-PD (Moderator) Mr. Leo Breirather, Great Lakes Coalition Mr. Henry L. Henderson, Chicago Shoreline Commission Mr. Martin R. Jannereth, Michigan Department of Natural Resources Mr. Douglas R. Cuthbert, Environment Canada Mr. Donald L. Totten, International Joint Commission
1145 - 1300	LUNCH	
1300 - 1330	Determining the 100-Year Flood Risk for the Great Lakes	Mr. Norbert F. Schwartz, FEMA
1330 - 1400	Great Lakes Coastal Flooding and PL-84-99 Advance Measures	Mr. Timothy J. Monteen, CENCD-EM
1400 - 1430	Great Lakes Wave Information Studies	Dr. C. Linwood Vincent, CEWES-CP-C

AGENDA (Concluded)

1430 - 1500	Chicago Lakefront	Mr. Henry L. Henderson, Chicago Shoreline Commission
1500 - 1515	BREAK	
1515 - 1545	Dynamic Equilibrium and Shoreliine Response to Fluctuating Great Lakes Water Levels	Mr. Charles N. Johnson, CENCD-ED-TG
1545 - 1615	Monitoring Completed Coastal Projects Program	Mr. Charles N. Johnson, CENCD-ED-TG Mr. Denton R. Clark, CENCB-ED-DC
1515 - 1700	Beach Nourishment - Objective, Design, Results	Mr. Thomas C. Nuttle, CENCE-ED-L
1700	ADJOURN	
20 May		
0800 - 0810	Opening Remarks	BG Patrick J. Kelly
0810 - 0830	North Central Division Research Needs	Mr. Zane M. Goodwin, CENCD-ED
0830 - 1000	Coastal R&D on the Great Lakes Present/ Future	Panel Dr. James R. Houston, CEWES-CV (Moderator) Dr. Guy A. Meadows, University of Michigan Dr. William L. Wood, Purdue University Dr. Keith W. Bedford, Ohio State University
1000 - 1015	BREAK	
1015 - 1045	Public Comment	
1045 - 1145	Recommendations by Members of the Board	CERB
1145 - 1200	Closing Remarks	BG Patrick J. Kelly
1200	ADJOURN	

OPENING REMARKS
AND
WELCOME TO NORTH CENTRAL DIVISION

BG Patrick J. Kelly opened the 49th meeting of the Coastal Engineering Research Board. He announced that MG Henry J. Hatch had been nominated two weeks previously as the new Chief of Engineers and was unable to attend the meeting due to involvement in the transfer from Director of Civil Works to the Chief of Engineers. BG Kelly noted that MG Hatch appointed him acting President to conduct the meeting.

BG Kelly designated the theme of this meeting as Coastal Engineering Implications of Changes in Great Lakes Water Levels. He noted the Canadian representative at the meeting because changes in Great Lakes levels affected both the United States and Canada.

BG Theodore Vander Els welcomed the CERB to North Central Division, and he expressed appreciation to the Detroit District for organizing the meeting. In relation to the theme of the meeting, he noted the importance of the Great Lakes. They contain 20 percent of the earth's fresh water and 95 percent of the fresh water of the North American continent. They benefit 12 states in the United States, about 45 million people, as well as a major portion of Canada. One third of the gross national product of the United States is within 300 miles of Chicago.

BG Vander Els said, "We Americans tend to take resources for granted. We treat them somewhere on a scale between nonchalance and outright contemptuous neglect sometimes." He pointed out that 7 or 8 years of extraordinary precipitation had raised the Great Lakes water levels several feet, prior to the more recent drop in levels. Seasonal storms had combined with the high lake levels to wreak havoc upon the shores, destroying property and eroding the shoreline.

REVIEW OF COASTAL ENGINEERING RESEARCH BOARD BUSINESS

COL Dwayne G. Lee, Executive Secretary
Coastal Engineering Research Board
Commander and Director
US Army Engineer Waterways Experiment Station
Vicksburg, Mississippi

At the last CERB meeting in Savannah, substantial interest was expressed in the areas of beneficial uses of dredged material and sand bypassing. A Gulf Coast Regional Workshop on Beneficial Uses of Dredged Material was held 3 weeks ago, on 26-28 April, in Galveston, Texas. The workshop was sponsored by Southwestern Division and the Galveston District, with coordination assistance from the WES Environmental Laboratory and CERC. Prime areas of technical interest included beach nourishment, land stabilization, habitat development, and innovative uses such as aquaculture. Representatives from Federal, state, and local agencies discussed their viewpoints in panel sessions at the beginning of the workshop.

In the area of sand bypassing, a CERC engineer, Mr. James Clausner, traveled to Australia in December 1987 to gather information on the design and operation of the sand bypassing system at the Nerang River entrance in Queensland. The Nerang River bypassing system is one of the few sand bypassing systems in the world designed and implemented as an integral part of a new coastal navigation project. The system recovers sand with a line of jet pumps deployed from a pier traversing the surf zone. Mr. Clausner has disseminated the knowledge he gathered through a variety of mechanisms, including a workshop held last month for Corps Districts actively designing sand bypassing systems, and a paper presented at the Beach Preservation Technology '88 Conference. A future workshop is being planned as a cooperative effort between CERC and Los Angeles District to incorporate experience gained with the Oceanside, California, experimental sand bypassing system. A new Corps PROSPECT course on sand bypassing systems is scheduled for May 1989.

For the past several meetings we have discussed the Private Sector Initiative, first brought up as one of the Chief's Initiatives at the 44th CERB meeting in Sausalito, California, in November 1985. Section 9 of S. 2101 (the Army's legislative proposals) would authorize the Secretary of the Army to undertake a 2-year demonstration program to provide technical assistance,

on a non-exclusive basis, to any United States firm which is competing for, or has been awarded, a contract for the planning, design, or construction of a project outside the United States. The United States firm must provide funds to cover all costs of such assistance. The assistance would be subject to various conditions outlined in the bill. This section of the bill has been incorporated into the proposed Water Resources Act of 1988 (S. 2100). Another means of interaction with the private sector became possible when the Assistant Secretary of the Army for Civil Works initiated the Construction Productivity Advancement Research Program (CPAR), which provides for cost shared R&D between the Corps and the private sector. This new Research and Development (R&D) initiative is intended to produce research results immediately transferable to the private sector.

I also can report on the status of several action items addressed at Headquarters USACE.

The lowest-cost dredging alternative policy is being reviewed at Headquarters to determine if shore protection and navigation projects can be combined so that materials dredged for navigation purposes can be placed in areas needing sand. If such project combinations are authorized, sand placed on the beaches could then be the least-cost action when the total project is considered. The tests now underway in the Mobile District on the feeder berm concept, if successful, will demonstrate a further reduction in the costs of nourishing a beach and providing lower-cost placement.

Discussions are underway in Headquarters of the policy implications of including benefits for down-drift beaches (outside project limits) in our analyses of beach nourishment projects. It is relatively easy to estimate the quantities of sand that move to adjacent beaches (which diminish with time and distance), but quite difficult to calculate the dollar benefits and how to cost share with the beneficiaries for that increased benefit.

Our last meeting had a theme of "Coastal Engineering Implications of Sea Level Rise." A draft Engineer Circular (EC) providing guidance on analyzing the possible impacts of future sea level rise on project formulation is being reviewed within Headquarters at this time. A draft will be sent to the FOA's for comment about 15 June 1988. This guidance was discussed at the recent Planning/Policy Conference. The essence of the guidance is that plans should be based on extrapolation of the local, historical record of relative sea-

level rise. A sensitivity analysis should be performed to determine the sensitivity of the design to changes in sea level. If future sea level rise rates can be confirmed by further study, then projects that are sensitive to large increases can be designed to allow for future modifications.

Monitoring of beach restoration projects was discussed at our last meeting. Monitoring of Completed Coastal Projects (MCCP) is presently funded from Operations and Maintenance (O&M). Because the Corps has no O&M responsibility for beach projects (that is a local responsibility), we put our limited funds into those coastal projects where we do have an O&M responsibility like breakwaters, jetties, etc. One option for collecting the necessary data on beach projects, which are often constructed by periodic nourishment, is for funds from the construction budget to be set aside for monitoring over the life of the nourishment - usually 50 years. Although recent authorizations for construction contain language that monitoring for the life of the project is necessary, to our knowledge the funds are not so budgeted. Other options are being investigated, for instance, creating a new budget line item to provide a Corps-wide fund for post-construction monitoring of projects involving periodic nourishment.

We reported on COASTNET at our last two meetings. COASTNET is the computer-based teleconferencing network that links the coastal engineering community of the Corps. The system presently has a total of 65 active members, including representatives of all coastal Divisions and Districts, Headquarters, and Labs. Our goal is to have one person in each major element of each office with a coastal function on the net, which means approximately 20 to 25 additional identification symbols (ID's). Within each element (planning, engineering, and operations), the personnel share the assigned ID. There are no users from outside the Corps because some of the discussions on the network are of a proprietary nature, and there is no provision for non-Corps users to pay their share of the network costs.

The Board has previously discussed the Automated Coastal Engineering System (ACES), and at our last meeting we indicated that we would be releasing ACES to Corps field offices. We have made an initial release on ACES, and other work is progressing. I would like to turn the floor over to Mr. John Oliver, who will provide further information on the status of ACES.

Mr. John Oliver reported on the status of the ACES. There are nine programs running and ready for release. Since the previous CERB meeting, five regional workshops were set up to distribute the programs to various districts and provide training in their use. There was also a survey of ACES users. Survey results show a 25 percent cost savings in planning studies where ACES has been used. There is also about a 10 percent reduction in final design costs when the ACES programs are used. He said that ACES would be expanded during the remainder of the fiscal year, and new programs would be going out to the field in the following fiscal year. He said that there would be a public release of the first nine programs in the third quarter of FY 89, after full documentation of the programs was available and they have received enough Corps usage to assure that they are completely debugged. A meeting was scheduled for August to discuss hardware and future actions. They are looking at a future configuration around the next generation of personal computers, and the Districts will be kept informed on what that configuration will be.

DISCUSSION

In relation to the private sector initiative it was noted that this is now a legislative proposal before Congress. BG Kelly said, "I want to compliment everybody in USACE Headquarters, and especially the WES staff, COL Lee and your people, for pursuing that."

As a result of the discussion on sea level rise at the previous CERB meeting in Savannah, the Board of Engineers for Rivers and Harbors was tasked to look at existing policies and to make a recommendation to the Director of Civil Works as to what might be done in the near term. There was a recommendation that the Corps publish a revised criteria in coastal engineering to take into consideration sea level rise. There is an EC being issued, and COL Lee covered its highlights. There was still some ongoing discussion with the BERH staff about some of the details. BG Kelly requested copies of the EC be sent to the CERB for review.

A recent report from NASA's Goddard Space Flight Center on global temperature change was mentioned. The report indicates that three or four of the warmest years in the past 100 years of record occurred during the 1980's. That raises a question on whether we are starting to see the global impact of the greenhouse effect. The NASA report did not discuss sea level changes, but there are members of that team that are looking at the effect on sea level.

In the area of postconstruction monitoring, it was noted that several actions were being generated, one being an Engineer Regulation (ER) outlining requirements that the local sponsor maintain the project. There is an existing ER outlining maintenance requirements for flood control projects. A

letter to the Corps Divisions is being prepared asking them to inventory their coastal protection projects with respect to how they are performing, and what monitoring and periodic inspection actions are being taken.

The use of ACES in engineering design was discussed. Final design phases of a project require very sophisticated modeling, and ACES does not perform that function. A questionnaire was developed to obtain information from field offices on their use of ACES, and feedback is being obtained.

PROPOSED EDUCATION PROGRAM FOR COASTAL SPECIALISTS IN THE CORPS OF ENGINEERS

Dr. James R. Houston
Chief, Coastal Engineering Research Center
US Army Engineer Waterways Experiment Station
Vicksburg, Mississippi

At the 44th meeting of the Board held in Sausalito, California, in November 1985, LTG E. R. Heiberg said the following in his Charge to the Board ..."One other continuing Charge ... is the responsibility that the Board has for addressing coastal engineering education. It is just a plain recognition of the fact that to a certain extent, we have to grow our own professionals. We do not have enough in the Corps, and if we do not grow them ... they are probably not going to get grown. ...find some innovative solutions whereby through cooperative programs, CERC and the universities, as an example, may get together and find ways to help with this challenge of educating professionals for the future ...."

In response to this Charge, the Board encouraged WES to accelerate its efforts to expand the WES Graduate Institute to include Texas A&M and Louisiana State University. The addition of these two schools would make courses in coastal engineering and related fields available at WES. COL Allen F. Grum (then Director of WES) reported at the next meeting held in Alaska in May 1986 that the two schools would be part of the Institute and courses would be offered that Fall. This provided a great first step in meeting LTG Heiberg's Charge.

At the Alaska meeting, BG Kelly (then Board President) formed a Working Group to look into the "health" of coastal engineering in the Corps and to make recommendations on, among other areas, education/training needs of our coastal specialists. The Working Group was made up of Messrs. Herb Kennon, Jesse Pfeiffer, Jay Lockhart, John Housley, and Charles Calhoun. The Working Group conducted six regional meetings with over 100 of the Corps' coastal specialists attending. In their report they noted that "...long-term training at the WES Graduate Institute possibly through a Planning Associates type program was met with much favor." They recommended that a program be developed tailored specifically for Corps' coastal specialists that would lead to a degree. They also noted that the curriculum for the program should include dredging.

At the May 1987 Board meeting in Corpus Christi, WES was directed to conduct a survey of training and education of the Corps' coastal specialists to further define training needs. COL Dwayne G. Lee presented the results of the survey to the Board at the last meeting. The survey revealed that there was a high level of interest in a 3- to 4-month specialty training institute as well as the 1-year program leading to a degree. At the same meeting, MG Hatch reported that LTG Heiberg was in agreement with the Working Group's recommendation that an educational program be developed and charged WES with the development. However, LTG Heiberg stressed that it would not be feasible to conduct a program analogous to the Planning Associates (PA) Program. The PA Program is a yearly program involving a much larger community than the coastal engineering community and is totally a Corps of Engineers program. LTG Heiberg called for a program that would also involve the university sector in addition to CERC.

We have developed a program that meets LTG Heiberg's Charge and the needs developed by the Working Group through the six workshops with field people. The program would fit under the current long-term training program of the Corps and be held at time intervals (probably 3 years) and group sizes (five to eight people) that reflect the size of the coastal community.

The program would be a joint one between the WES Graduate Institute and Texas A&M University. Figure 1 is a curriculum of the program. Participants would spend about 9 months at Texas A&M and 3 months at CERC. Participants can earn a Master of Engineering degree from Texas A&M at the end of the program. While at Texas A&M, they would take the basic courses required for a solid academic background in coastal engineering. The semester at WES would provide highly specialized courses reflecting Corps needs and approaches to problems, including numerical and hydraulic modeling and field measurements at CERC's Field Research Facility. Every one to three participants would have a CERC mentor and work on a major engineering problem that would allow him to use tools such as numerical or hydraulic models and field measurements and also qualify him for the Master of Engineering degree. The courses at CERC would be taught by CERC personnel accredited with visiting professor positions at Texas A&M University. In addition to personnel in the long-term program, coastal specialists in the Corps that already have a firm academic background in coastal engineering could attend just the 3-month course at WES.

The proposed program can be implemented under the current long-term training program of the Corps. The Corps sends about 30 people per year to school under this program. Once the program is advertised, we would have an under representation of coastal specialists for long-term training in the couple of years that the program is not offered and an over representation in the year it is given. We would need this to be recognized at USACE to allow the over representation once every 3 years.

The mechanisms are in place through the WES Graduate Institute to implement the proposed program. Texas A&M University has agreed in principle to participate. We would like to initiate the program for the school year beginning in September 1990. We believe the program provides for the technical needs we have heard and will provide new and exciting dimensions to the Corps recruitment and retention packages.

FALL TERM TAMU	#	Coastal Sediment Processes	3
	*	Physical Oceanography	4
	*#	Ocean Wave Mechanics	3
	*	Higher Math	4
	*#	Seminar	1
			15
SPRING TERM TAMU	#	Coastal Engineering	3
	#	Marine Dredging	3
	*	Hydromechanics	3
		Elective	3
	#	Coastal Problem	2
	*#	Seminar	1
			15
SUMMER TERM CERC	#	Theory of Fluid Mechanics Models	3
	#	Computational Fluid Dynamics	3
	#	Coastal Field Measurements	3
	#	Coastal Problem	3
			12

Total Program: 42 Credit Hours

* TAMU Requirement # CERC Requirement

Figure 1. Curriculum

DISCUSSION

There was some concern expressed that this program required completing a degree in 12 months, when many students require 18 to 24 months to complete a Masters degree. It was noted that these students would be full-time with no other duties, while many university students are teaching assistants, for example, and cannot devote 100 percent of their time to their degree programs. Also, many of the longer breaks in the school year were being eliminated. The overall program actually requires some additional credit hours over the number required by the university for a degree.

A question was raised about how universities are selected for the program. It was pointed out that Army regulations require that programs at an Army installation be set up through the university system of the state where the the installation is located. Consequently, the original program at the WES Graduate Center was set up through Mississippi State University. This was expanded to include Louisiana State University and Texas A&M in order to add additional fields of specialization which were not available in Mississippi, e.g., Ocean Engineering.

There was discussion on the budget for the program and the anticipated source of funding, and also on whether engineers from outside the Corps of Engineers, e.g., from the private sector, could participate in the program. The funding would come from the existing long-term training program within the Corps of Engineers. Participation by engineers from outside the Corps has been considered and would be beneficial. BG Vander Els recommended participation from the military side since the Army sends younger officers to universities for graduate level training. With only Corps participation, the program might be offered once every 3 years. With participation by others, it might become a yearly program. There was also some discussion of involvement by other universities, and that will be looked at in the future.

UPDATE OF FY 88 COASTAL ENGINEERING R&D PROGRAM

Dr. James R. Houston
Chief, Coastal Engineering Research Center
US Army Engineer Waterways Experiment Station
Vicksburg, Mississippi

The Coastal Engineering R&D Program is the General Investigations funded portion of CERC's budget that is used to address the systemic problems of coastal engineering. The Coastal Engineering Research Board (CERB) traditionally provides review and guidance to CERC on this program. The FY 88 funding status of the program was not known at the last CERB meeting because a budget had not been passed by Congress.

The final FY 88 budget of $5.2 million for the Coastal Engineering R&D Program is about 6 percent above the FY 87 budget. This is the first year this decade that the budget for this program has not decreased. The FY 88 budget is still about $1.7 million below the FY 81 budget in actual dollars. Credit for reversing this long-term trend goes to MG Hatch, who provided the testimony that convinced Congress, and Mr. Jesse Pfeiffer of the Directorate of Research and Development. The Corps actually recommended an increase twice as large as the one obtained and convinced the Office of Management and Budget to include this increase in the President's budget. The Senate Committee passed the larger increase and the House the smaller. The Conference Committee was facing the intense budgetary pressures of the last year and finally passed the smaller increase. The Corps has testified for another increase in this budget for FY 89.

We have made several changes to strengthen the Coastal Engineering R&D Program over the past few years. Dr. Linwood Vincent was named Program Manager for all four of the Coastal Engineering R&D Programs. He replaced four separate people that handled the programs as other duties. This year we performed detailed CERC peer reviews and reviews by district and division personnel of all existing and proposed work units prior to the Program Review to ensure our efforts were of the highest quality and responsive to user needs.

The FY 89 Coastal Engineering Program Review was held the week of 2-6 May 1988 at CERC. Civilian CERB members attended the Review for the first time. Two additional USACE Technical Monitors from the Operations and Readiness and Dredging Divisions joined our traditional monitors from the Engineering and

Planning Divisions at the Review. A new standing Field Review Group representing all of the Coastal Districts and chosen by the Technical Monitors provided review guidance at the Program Review and replaced ad hoc groups of field users that attended previous reviews. To ensure a well-integrated total program, the Coastal Field Data Collection, Monitoring Completed Coastal Projects, and Coastal Geology and Geotechnology Programs were all reviewed on days subsequent to the Coastal Engineering Program Review. Comments from participants in the Program Review indicate that the users of our R&D work believe the programs are of high quality, well-integrated, and meeting needs of the field.

DISCUSSION

There was general agreement with the format used for the Program Review, and a recommendation to continue that format for future program reviews. A question was raised about the future of the Shore Protection Manual. It was pointed out the the Shore Protection Manual and the Engineer Manuals are being looked at to ensure that they are consistent. This is being discussed with the technical monitors. This is also being looked at from the standpoint of ACES to see what part of the technology can be placed in an electronic format for use on PC's. CERC expects to have a new Shore Protection Manual in the future.

FIELD TRIP

Mr. Steven M. Running, Area Engineer in the Construction Operations Division of the Detroit District, gave a briefing of the tour scheduled for Wednesday afternoon on 18 May. Mr. Larry Ryan of Warzyn Engineering, project engineer for the Racine Harbor project, gave a briefing on Racine Harbor. The tour then proceeded to Racine Harbor, which had been converted from an older commercial harbor into a recreational boating facility.

From Racine Harbor the tour proceeded North along the Lake Michigan shoreline, stopping at Wind Point Lighthouse where riprapping was recently installed around the structure to solve a serious erosion problem. From Wind Point, the tour proceeded to Sheridan Park in the city of Cudahy to view an older groin field installed in the 1930's and an adjacent high bluff which is experiencing erosion and sloughing. The ground tour then ended at Milwaukee Harbor, where the tour group boarded a boat for a tour of a major rehabilitation program in Milwaukee Harbor to repair 6,000 lin ft of breakwater structure at a cost of approximately $11 million. Other points of interest on the boat tour were the Summerfest grounds, the Milwaukee Metropolitan Sewage Treatment Facility, City of Milwaukee cargo warehouses and docks, Milwaukee County Juneau Park, and McKinley Marina.

GREAT LAKES OVERVIEW

Mr. Ronald E. Wilshaw
Chief, Great Lakes Hydraulics and Hydrology Branch
US Army Corps of Engineers District, Detroit
Detroit, Michigan

The Great Lakes and their connecting channels make up the largest body of fresh surface water in the world, with a total surface area of almost 95,000 square miles. The Great Lakes basin covers a land and water area of approximately 300,000 square miles.

The uses of the Great Lakes are many and varied, such as for ship navigation, for hydropower generation, and for industrial and municipal discharge; they provide fresh drinking water and are widely used for recreational boating and fishing.

In the last 25 years, the Great Lakes have experienced a broad spectrum of water levels, from the record lows of the mid-1960's, to the mid-1970's and mid-1980's record highs. The latter high water periods have created a renewed awareness of the destructive forces of these lakes.

LAKE LEVEL FLUCTUATIONS

Why do the lakes fluctuate so dramatically? Great Lakes' levels are the result of the interaction of natural and artificial, or human, factors which affect the water supply to the system and the discharge from the system.

Natural Factors

The predominant natural factors impacting on lake levels are precipitation, runoff, and evaporation. Precipitation on the land portion of the basin recharges ground water, enters the lakes as runoff, or is lost as evapotranspiration. Evaporation, besides taking water out of the system, sometimes exceeds the rate of precipitation, causing lake levels to recede. Other natural factors include ice and weed retardation in the connecting channels, wind induced waves, severe barometric changes, minor tides, crustal movement and outflow to the next lower lake. These factors contribute to three types of lake level fluctuations: seasonal, long term, and short term.

Seasonal fluctuations usually follow the annual hydrologic cycle. In winter the water supply to the system is generally in the form of snow. In the spring, this snow melts and when combined with seasonally heavy rainfall,

causes the lakes to rise. During summer and early fall, evaporation increases causing the lakes to fall from their seasonal peaks and to progress towards their winter lows.

Long-term fluctuations, often referred to as cycles, occur over several years and are caused by periods of persistent high precipitation or combinations of low precipitation and evaporation. The length of such periods is variable and does not follow any predictable pattern.

The most dramatic changes in water levels are short-term fluctuations caused by strong winds and rapid changes in barometric pressure.

Artificial Factors

Diversions: Currently, there are five significant diversions of water into, out of, or within the Great Lakes basin: The Long Lac and Ogoki diversions divert water into Lake Superior that originally drained north into Hudson Bay. The Lake Michigan diversion at Chicago diverts water out of Lake Michigan into the Chicago Ship and Sanitary Canal and eventually into the Mississippi River. The Welland Channel, an interlake diversion, takes water from Lake Erie and diverts it across the Niagara Peninsula to Lake Ontario. The New York State Barge Canal diverts water from the Niagara River at Tonawanda, New York.

Lake Regulation: The International Joint Commission (IJC) was created by the Boundary Waters Treaty of 1909 and deals with the use, obstruction, and diversion of the boundary waters. Among other things, it regulates outflows from Lake Superior and Lake Ontario, the only two Great Lakes whose outflows are controlled by man. The IJC conducts its activities through control boards it appoints from qualified experts in both countries.

Dredging: Dredging has occurred in the St. Clair, Detroit, St. Marys, and St. Lawrence Rivers to provide improved channels for commercial navigation.

Consumptive Use: The term "consumptive use" refers to that portion of the water withdrawn or withheld from the Great Lakes and not returned.

Other Atmospheric Changes: Global climate change, related to a doubling of CO_2 and other trace gases in the atmosphere, may very well affect future lake levels.

Additional human activities, such as clearing forests, draining, irrigating, and urbanizing have also changed the hydrologic characteristics of the land area supplying water to the Great Lakes.

RECENT HIGH LAKE LEVELS

As a result of the high water levels of the past few years, extensive damage was incurred by shoreline residents throughout the Great Lakes basin. In low-lying areas (Lakes St. Clair and Erie), this damage resulted primarily from flooding. Along the Lake Michigan and Lake Superior shorelines, much of the damage resulted from shoreline erosion, causing total destruction of many homes.

PRESENT DECLINING LAKE LEVELS

Record light precipitation, beginning in late 1986, and progressing into mid-1987, resulted in dramatic changes in lake levels, causing them to begin trending downward. Today, Lakes Superior and Ontario are about 3 in. below their long-term (1900-1987) averages while Lakes Michigan, Huron, and Erie are still about 1 ft above their long-term averages.

FUTURE

In the last 35 years, the Great Lakes region has undergone three major periods of extreme high levels and one of low levels. Although man has some limited control over the levels of several of the lakes, the short-term and long-term cycling of the Great Lakes is principally the result of nature.

Lacking the capability to control the middle Great Lakes and in the absence of accurate long-range weather forecasts, it is a difficult task today to both manage the Great Lakes and to predict their future levels. Nevertheless, studies are being conducted which could influence, to some extent, future conditions on the lakes.

Forecast Improvements: Improvements to the present predictive system are being made and new hydrometeorologic forecast techniques are being investigated.

Better Data: Present efforts are concentrated in two areas: real-time data collection and data interpretation.

Gamma Snow Surveys: The Corps, in cooperation with the National Weather Service and the Water Survey of Canada, is conducting gamma snow surveys on the Lake Superior and upper Lakes Michigan, and Huron basins.

IJC Reference: Based upon a 1 August 1986, reference from the Governments of Canada and the United States, the IJC is examining and will report upon the adverse consequences of fluctuating water levels.

A possible long-term perspective on the future levels of the Great Lakes may be evident in historic Great Lakes water levels as determined through analyses of geological and archeological evidence. Of particular interest is the overall conclusion that the regime of lake levels in the past was much higher than that which exists today.

In conclusion, the Great Lakes is a remarkable body of water and will remain a serious challenge for coastal experts for centuries to come.

DISCUSSION

It was noted that the presentation concerns a very lively problem in terms of reaction from large segments of the population. The elevations in the Great Lakes are now decreasing, and Lake Ontario is measurably low. There is now a demand to do something about the low levels, including low water levels in the upper Saint Lawrence which are causing navigation problems.

GREAT LAKES WATER LEVELS
THE RIPARIAN VIEWPOINT

Mr. Leo J. Breirather
Past Chairman
GLC Wisconsin Lake Michigan Shoreline Chapter
Wilson, Wisconsin

Lake levels in all of the Great Lakes should be regulated individually and basin-wide to cause the reduction of extreme high and low lake level losses, to the extent that man is able, by promoting stabilization of Great Lakes water levels through effective and equitable hydraulic regulation of the Great Lakes system under a centralized management entity.

Riparians have the American right for equal (not less) consideration as all other economic factors when decisions are made affecting the retention or disbursement of water in the Great Lakes to enable them to plan development on the shorelines.

Past experience has shown that the cost factor attached to needed construction for possible stabilization of water levels is no greater than the huge expenditures encountered by private and public entities in warding off the real and potential damages created by high wave action during periods of extremely high water levels, or corrective action for utilization of the expected benefits of the Great Lakes during periods of extremely low water levels.

The myth that lakeshore public and private property owners are the only ones who suffer economic loss during periods of stress needs to be rebutted since valuable tax base can be destroyed or public funds are required to pay for reconstruction of public property or protection against potential losses.

Cost/benefit computations may not be allowed to become the final and compelling factor in determining the need for pursuit of remedial construction for regulation of water levels in the Great Lakes, because too much emphasis is placed on speculation which can be, and has been, found to be drastically erroneous.

The prevailing attitude among the public, created by some who should be expected to be competent in this area, that nothing can be done to alleviate the recurring problems related to extreme high and low water levels needs to be changed to a positive attitude. This will, at the very least, provide the kind of consideration that lends more than lip service toward accomplishing

the goal of eventual real and meaningful regulation of water levels to the extent that all who are subject to the water levels can live in harmony with each other with progressive economic and social expectations.

DISCUSSION

It was clarified that the Great Lakes Coalition was not taking issue with the International Joint Commission guidelines, but rather with the cost/benefit analysis which eliminated some of the possibilities which were available for regulating Great Lakes water levels. It was the feeling of the Great Lakes Coalition that the Corps of Engineers could do the job if there was public and political support to authorize the necessary action.

INTERNATIONAL JOINT COMMISSION REFERENCE - TASK FORCE AND COMPREHENSIVE STUDIES

Mr. Donald L. Totten
United States Commissioner
International Joint Commission
Schaumburg, Illinois

Mr. Totten presented an overview of the International Joint Commission's method of operation. One responsibility of the IJC is to investigate specific issues when requested by either or both governments. These investigations are known as References, and implementation of IJC recommendations under such References is at the discretion of the two governments. Study or advisory boards assist in References. Public hearings and other opportunities for input by interested citizens are organized when References are considered. The two governments sent the latest Reference to the Commission on 1 August 1986, and Mr. Totten discussed the policy ramifications of that Reference.

The Reference asked the Commission to produce two reports. The first was an interim report on alleviating the extreme high water levels that existed at that time. The second report regarded methods to alleviate future adverse effects of both high and low lake levels and, for the first time, included land use management and practices.

The Commission responded in three ways. They submitted an initial letter report recommending three actions to be undertaken by the governments; identifying emergency actions the Commission had already undertaken at Lakes Superior and Ontario; and listing seven measures that were technically feasible and could be undertaken by various entities.

The Commission's second response was to form an international task force to complete a technical evaluation of any measure that could be implemented within 1 year to alleviate the existing high lake levels. By the time that task force completed its assignment, the high water crisis had eased considerably. The second interim report to the governments will consider the task force result as well as current lake conditions.

The third response to the '86 Reference was to issue a set of broad instructions and create an institutional mechanism to undertake the comprehensive study of both high and low lake levels. In April 1987, the instructions, known as a directive, were issued and a project management team, co-chaired by BG Vander Els of the Corps and Elizabeth Doddswell of

Environment Canada, was appointed to oversee the conceptualization and management of the study. The project management team's basic plan of study was approved in March 1988, and an excellent final product is anticipated. The comprehensive study has an immense size.

As long as the lake levels and the flows in the connecting channels remain within an as-yet-undefined "band of satisfaction," there is no problem. Problems occur when the levels and flows are either too high or too low with respect to the user interests. No one predicted the occurrence of record-setting high levels of '85 - '86, nor was there any means in place to cope with them adequately. The Corps and several others had, or created, site-specific emergency and self-help programs to provide a measure of relief.

Numerous technical problems are covered in the comprehensive study. A partial list would include: How high and how low will the lake levels go? When? How do you distinguish between the normal process of erosion and that increment produced by abnormal lake levels? How should we factor in the greenhouse effect which current research indicates could lower the lake levels, on average, from 1 to 8 ft.

The Commission agreed that the study should be as open and accessible as is reasonable. The assumptions and judgments that are made, the methodologies used, the analyses undertaken, and the results should be available to those that have the interest and resources to examine them. The Commission will strive for agreement on the factual data information and analyses that will drive all the alternatives, considerations, and recommendations made. They have already reached agreement on the basic hydrological data to be used.

One issue is cost sharing. The Federal/non-Federal split has always been subject to debate, and this study adds the complexity of two sovereign nations with quite different separation of powers with their states and provinces. It is anticipated that closely tied to cost sharing will be the issues of distribution of benefits, the impact of disbenefits, and the applicability of remedial and compensatory costs. One commissioner has suggested development and acceptance of a set of basic principles that would establish the primary set of ground rules under which actual negotiations on cost sharing would proceed in order to facilitate the process.

More subtle areas are the explicit and implicit philosophy and attitudes of the various groups and individuals involved. The challenge is to ensure that

the study is unbiased in fact and in appearance in order to overcome any counterproductive perception. Only in this fashion will decisions, made on the merits, not be subject to challenges of being predetermined or prejudiced. The IJC comprehensive study is expected to uncover differences of attitude and philosophy that will impact on the study and influence future actions in the Great Lakes basin.

Technical problems are inextricably linked to matters of policy. One of those is the uncertainty of forecasting future water supplies to the lakes and their resulting levels. That uncertainty is compounded by the potential greenhouse effect. The risk that any degree of protection will be exceeded becomes a policy issue as the amount of risk acceptable will vary significantly among decision makers.

The last policy issue is the most difficult and yet is paramount to the successful culmination of the comprehensive study. It has to do with the multitude of governments and interests that have a stake in the future of the Great Lakes basin, each with their own role and responsibility. In 1964, the Commission received a Reference pertaining to water quality in Lakes Erie and Ontario. In 1985, the problem was high water levels, and the two nations were not well prepared to cope with the emergency. The Commission's interim report in 1986 documents to some extent the deficiencies that existed in coping with the record high water levels.

The basic question is: Are the institutions in the United States and Canada any better prepared to deal with crises brought about by fluctuating water levels than they were in 1964 for water quality, or in 1985 for record high levels? That does not appear to be the case. If there were a single international institution with decision making authority, the current study would be simplified, although not simple. The IJC will continue to serve in a fact-finding and recommendation capacity. The respective Federal governments have an international and domestic consultant and decision-making process that can function quite well.

The concern is that the present Reference study has a large number of issues on which there are undoubtedly strongly held but differing views by governments and interests, and which may significantly affect the two countries. These issues are so fundamental to the study itself that consultations on both sides of the border regarding those differences and

views cannot wait until the basic study process is over, but must be part of the actual process itself. The Federal governments were able to fulfill this role in reaction to the water quality problems in the 1960's.

The commission study is expected to define a number of differing views that exist among governments and interests, and may make appropriate recommendations in such a fashion that would contribute to a successful study project, yet not prejudice or appear to co-op the ultimate decisions by those consultants.

Advice given to the governments by the Commission, in its Diversion and Consumptive Uses Report, is still relevant and important. That advice was, based on the experiences of the United States and Canada with regard to the 1972 and 1978 Great Lakes Water Quality Agreements, the two governments would be well advised to engage in broad and systematic discussion of their use of Great Lakes water before they are faced with any sense of crisis, actual or imminent, and before any relationships deteriorate or become jeopardized.

DISCUSSION

A question was asked about the funding and the timing of the present study. It was noted that the two national governments have overlapping fiscal years, which makes funding an interesting exercise, but that both governments have provided funding. The first phase of the report will be available in 1989, but the cross-impacts, the modeling, the gathering of data, and answering the "what if" questions are probably beyond their ability to complete by 1989. The final part of the report will be available in 1991.

It was stated that the policy option of land use planning is long overdue. There are a number of examples along the Great Lakes shorelines where some judicial application of land-use planning could have alleviated a number of problems. It was noted that land-use practices are a new venture for the Commission, and as yet there were no recommendations on the concept of setback lines.

There was discussion of how the study was structured. There are two lead commissioners, one from the United States and one from Canada. Mr. Totten is the lead US commissioner. There is a steering committee that oversees the policy; BG Vander Els and Elizabeth Doddswell from Environment Canada are on that committee. There are two lead staff members from each staff. They set up a project management team. Five areas were identified and functional groups were set up. They call on various experts from academia or industry for assistance. The functional groups have co-chairs in place and have been working on the studies. Something new is Functional Group 4, which is a public information group. There are representatives of academia, state

government departments, various interest groups such as the Great Lakes Coalition, and agencies from both countries such as the Corps of Engineers and Environment Canada.

PANEL
PROBLEMS AND ACTIONS RESULTING FROM FLUCTUATING LAKE LEVELS

Mr. Kenneth H. Murdock, Moderator
US Army Engineer Division, North Central

Mr. Leo Breirather
Great Lakes Coalition

Mr. Douglas R. Cuthbert
Environment Canada

Mr. Henry L. Henderson
Chicago Shoreline Commission

Mr. Martin R. Jannereth
Michigan Department of Natural Resources

Mr. Donald L. Totten
International Joint Commission

Mr. Breirather offered information on problems encountered in organizing the Great Lakes Coalition. There was a problem because people attach different meanings to the word "diversion." "Diversion," to most people, meant using Great Lakes water to supply other areas of the country. The Council of Great Lakes Governors, under the impression that the Great Lakes Coalition favored this, took a position opposing diverting Great Lakes water to other parts of the country. The Coalition was actually referring to allowing more water to flow through the natural connecting channels. The position and attitude of the Governor of Wisconsin changed when he understood the actual intent of the Coalition and is now working to change the positions and attitudes of other governors on the Council.

The coalition realizes there are limits to regulating the levels of the Great Lakes, but any kind of regulation that takes away the extreme highs and extreme lows would be adequate. There are no illusions that absolute regulation is possible.

The primary emphasis has been on regulating Lake Superior and Lake Ontario; but all the Great Lakes need regulation, and it should be done properly and totally. The coalition understands that if there is unusual rainfall in any immediate area it takes 3 years to spread evenly over the entire system, and that allows regulators 3 years to make necessary adjustments. In their position paper, the Coalition went to great lengths to obtain substantial

competent advice. The Canadian section of the Great Lakes Coalition has accepted that and has presented it to their Government. The Coalition is now in a position to contact the political entities that can provide the necessary impetus and appropriations.

Lake level regulation is feasible. The Coalition is aware that this is a political and an engineering problem. They feel it is their job to get the political climate to allow the IJC, Army Corps of Engineers, and anyone else involved to study this in a positive manner, and make recommendations to Canada and the United States Governments to make lake level regulations possible.

Mr. Henderson said the City of Chicago has sustained extensive damage to its Lake Michigan shoreline as the result of fluctuating lake levels. Both the record high levels of the past several years and the record low levels of the early 1960's have taken their toll on Chicago's man-made shoreline. The high levels have increased the power of lake storms to batter the structures and beaches built on the shore by Chicagoans. The low levels have exposed to air and consequent dry-rot the wooden pilings that hold up the step-stone revetments of the Chicago shoreline, causing them to crumble and collapse. Thus Chicago has experienced directly the negative effects of fluctuating lake levels, and the failure to properly plan for fluctuations on a man-made, urban coast.

In the midst of the damaging high lake levels of 1986-87, Honorable Harold Washington, the late mayor of Chicago, appointed a commission drawn from professional, scientific, community, and governmental circles to study the problems facing the Chicago shoreline and report to him with a recommended plan identifying steps to respond to the problems. Among the first things identified by the Commission was the need to accomodate the fact that the Lake fluctuates. It became a key design criteria for the Commission in evaluating and recommending any project to the Mayor, that the project be adequate in high and low lake regimes. The resulting recommendations include a mixture of beaches, gradually sloping revetments, and extension of publically held land to shield private property and development from fluctuating lake levels and storms, and break waves as gradually as possible. Chicago cannot move back from the Lake; we recommend moving the Lake further out.

Mr. Jannereth said water level fluctuations on the Great Lakes wreak havoc with development. High water levels flood homes, businesses, and infrastructure. Accelerated erosion causes tens of millions of dollars in damages and leads to demands for shore protection. Low water levels limit recreation and navigation.

The total cost of damage and protection from Great Lakes high water in Michigan in 1985 and 1986 was estimated between $150 and $175 million. These costs placed a great strain on both the public and private sector as each responded to the crisis.

Special assistance programs were developed to deal with high water problems and existing programs were expanded. In addition, all programs were reviewed and several changes were deemed necessary. Michigan is now trying to implement some of these program changes, but progress has been slowed by the rapid decrease in water levels and a resistance by property owners to any new land use regulations.

Lower water levels are creating other problems on the Great Lakes. Permit applications have changed almost completely from shore protection to dredging applications. Serious problems with dredged disposal, wetlands and fish spawning protection, and contaminated spoils make dredging during low water levels nearly as large a problem as high water hazards.

The CERB has the opportunity to be instrumental in the scientific research necessary to support the Great Lakes states' efforts to reduce future losses from fluctuating water levels.

Mr. Cuthbert indicated that most of the problems experienced in Canada relating to the recent record high water levels and long-term fluctuating levels of the Great Lakes are similar to problems encountered in the United States. The scale of the problems and the reaction of the public and politicians may, however, exhibit some differences. Also, many societal and governmental actions addressing the lake levels problem are similar, but there are some characteristically different steps being taken in Canada that could affect how our two countries jointly act to resolve the issue.

In Canada there appears to be less emphasis being placed on "structural" solutions to the problem and more emphasis placed on public education, land use controls, and shoreline management. In Canada the involvement in the issue of one province compared to eight US state jurisdictions and the

different Federal/Provincial versus Federal/State mandates causes a variance in lake level related actions. Furthermore, in Canada, regional Conservation Authorities and local municipalities can and do play a large role in acting to resolve shoreline damage problems.

Some Canadian problems and activities relating to the Great Lakes water levels issue will be summarized with the objective of providing "a view from the other side of the Lakes."

Mr. Totten discussed what had been done on the IJC's task force reports that they were finalizing. The task force was asked to look at matters that were technically feasible to implement within 1 year to meet a crisis. The tasks were divided into eight areas, and the purpose of the task was to report or develop technical information on possible crisis action measures.

The first task was to see if additional water could be stored in Lake Superior. That was divided into two parts. The first part addressed the technical feasibility of increasing the storage on Lake Superior above the 602 ft level, the maximum presently allowed in the IJC's orders of approval, and the associated physical impacts if the level went above that. When the proposed study became public knowledge, there was reaction from riparians on Lake Superior who were undergoing crisis problems with the 602 ft level and did not want the Commission to consider anything above 602 ft.

The second part reviewed existing information to identify the maximum historic Lake Superior water level. The task force found that the regulating structures can accommodate a water level of about 602.8 ft at the compensating works, or about 603 ft on Lake Superior, so it is technically feasible to raise Lake Superior to 603 ft. That would reduce levels on the other Lakes. A maximum historic level of 602.3 ft is likely to have occurred in August 1876.

The second task was to look at the Lake Ontario-Saint Lawrence River level. At the same time the lake levels were high, there was a low level on the Saint Lawrence River, and complaints from the recreational and navigational interests were received. The task evaluated the technical feasibility of moving or modifying four constraints on Lake Ontario outflow. These included agricultural lands downstream of Montreal, commercial and industrial lands surrounding Lake St. Louis, navigation depth requirements in the International Rapids section of the Saint Lawrence River, and maximum

outflows during the navigation season. The hydrologic impact of removing or modifying all constraints except Lake St. Louis are included in the report.

They also looked at five diversions, and what the effect would be of modifying some or all of those. The Council of Great Lakes Governments is opposed to increasing any of the diversions, particularly the Chicago diversion which is limited by a US Supreme Court decision to a maximum of 3,200 cu ft/sec.

The fourth task involved the Niagara River, the natural outlet of Lake Erie. Its natural constricting effect has been compounded by structures placed in the river. They looked at the maximum effects of a number of different measures, including the removal or modification of flow obstructions in the river.

The fifth task was to look at Saint Clair-Detroit Rivers. The effects of removing Detroit River compensating works and placing works in the Saint Clair River are practically negligible.

They looked at ice management and found that placement of an ice boom in the Saint Clair River could help prevent ice jams caused by the outflow of Lake Huron ice, and that would have some effect. They then combined all the hydrologic impacts and produced a scenario that showed what would happen.

Task seven inventoried shoreline management activities and emergency measures. The overall report was finalized in June and sent to the governments.

DISCUSSION

Mr. Breirather made reference to Mr. Henderson's and Mr. Jannereth's remarks on better shoreline planning and setbacks. He noted that houses that had been set back after a previous high water were still in serious danger in 1985 and 1986. Also, some people had run out of land and had no place to move. No one knows what setback is actually needed unless there is reasonable lake level regulation.

Mr. Henderson noted Mr. Totten's statement of a need for a binational approach to lake level regulation and asked if there was an interest on the Canadian side and how one would move forward on that.

Mr. Cuthbert said that lake level regulation would not entirely resolve the problems of riparians. There are riparians in the United States who are in the process of a lawsuit because they claim that regulation has made their situation worse. He thinks we need a combination of regulation and shoreline

planning. Through the vehicle of IJC, there can be an understanding of the options; of what people can generally accept across the basin; and then a blending of those plans which would take into account regulation and planning. There is a need to understand the situation from all the different viewpoints, and find a common goal.

Mr. Jannereth agreed that regulation and shoreline planning were both needed. He noted that the lower water levels had removed the pressure to do something, and it was becoming more difficult to implement proposed changes. Private property owners are developing resistance and concern about some of the regulations.

Mr. Cuthbert asked how varying lake levels affect shoreline erosion. He pointed out that each shoreline is different. He said there is a general conception that lower lake levels will reduce shoreline erosion, but he did not think that was true in a general way. He thought this was an area for research in both countries. He also asked if the possible emergency conditions from low water levels in the next 2 or 3 years was being addressed.

Mr. Totten said that the IJC makes recommendations to the governments, but that the governments may or may not act on the recommendations. If study results are presented to the governments at a time when there is no crisis, inaction may result. That can be frustrating to the IJC and the people involved in the studies. The Commission has not initiated studies on crisis actions for the case of low water levels. The IJC cannot initiate a study; they can only react to what the governments refer to the Commission. There are some major policy and philosophical differences on the horizon which could impair any action on the present study unless we resolve them before they occur.

In response to a question from Mr. Breirather, Mr. Cuthbert reiterated his statement that erosion may be independent of lake levels. This will vary from area to area because of different physiographic shoreline conditions.

Dr. Nummedal said that our main concern along oceanic shores has been with sea level rise, and we have not concerned ourselves with sea level fall. We need to understand if the Bruun rule works in reverse. If you get accretion on the beach, do you get related scour offshore. He referred to an upcoming field experiment on the Great Lakes, and asked if a component of that experiment would be the potential onshore movement of sand and gravel if there is a reduced water level.

Dr. Houston said it would be a very short-term experiment and would not consider that.

Dr. Nummedal asked what was being done to push legislative bills for shoreline setback measures and some of the other initiatives to keep them active. He also noted that the state of North Carolina had a double setback, different setback lines for different sized structures. Mr. Jannereth said they were following the North Carolina example, and were putting forth a proposal for new administrative rules that would require the double setback among other things.

BG Kelly noted, in regard to lowering water levels, that lakes in other parts of the country also had problems with shoreline erosion during droughts. He specifically mentioned experience in Alabama, Georgia, and Florida.

Dr. Le Méhauté asked, considering the lakes as a system, if there had been an overall investigation to tie together all of the effects in economic terms.

BG Vander Els replied that was one of the objectives of the study, and it's a very difficult task. This study will not quantify things precisely. It will quantify some of the impacts, but in other instances will just give an order of magnitude of the impact. It will provide a logical interrelation rather than a precise numeric solution.

Mr. Cuthbert added that the present study is not the first attempt at systems analysis. There was a study in the early 60's that concluded that the benefit/cost ratio did not justify further Great Lakes regulation. There were two subsequent studies, one looking at Lake Erie which concluded there be no further attempt at regulating Lake Erie. There was a dissatisfaction that the previous analyses did not go further and did not include all the viewpoints, so the present study is the third or fourth in a system of series analyses.

Dr. Mei referred to comments which had been made concerning the role cohesive sediments might play in shoreline processes. He thought that CERC could play a major role in contributing to this type of research.

A question was raised about what maintenance or monitoring procedures were established to ensure the continued presence of a filled lakefront.

Mr. Henderson said that they had found that issue had been badly neglected. A primary result of the Chicago Shoreline Commission's work should be to make sure that a consistent monitoring and maintenance program be established. The original work was done by various park districts which have since been unified into the Chicago Park District. Studies done in the '20s for the Lincoln Park District indicated that consistent maintenance over what was then about 10 miles of shoreline at a cost for basic maintenance of about $600,000 per year in 1920's dollars. That was never properly budgeted. This has led to the radical need for rebuilding because of the cumulative effects of no maintenance. The step-stone revetments were designed to be easily maintained because they could be lifted up to provide access. Lost material underneath could be replaced, and the stone reset. A second generation of park people did not understand that and cemented the tops. A recent survey showed that large losses of material had occurred because the original intended procedures of lifting up the stones for inspection had not been followed. They found sixteen 20-ft holes under the existing shoreline, and a lot of the step-stone is being held up by a veneer of concrete on top and bridge action from stone to stone. While this just came to the attention of the Park District, it was well known to children who had been swimming into those caverns and grottos.

The City of Chicago has learned that any cost figures for shoreline development or rebuilding have to include maintenance costs, and a fund needs to be established which can be used only for shoreline work. Funds from

marinas or other shoreline activities are now merged into the general corporate budgets. The current Chicago Park District Board is responsive and has started budgeting for maintenance, and the city is responsive to that.

Mr. Keillor pointed out that plans for improvements in lake regulation should be tested using hydrologic response models. It is necessary to determine if proposed measures would provide a fast enough response to be beneficial when there were extremely wet or dry years causing major changes in lake levels. Controls have to be implemented early enough to have an effect, and it is necessary to consider how much advance warning there would be.

Mr. Cuthbert said that was a basic problem. Attempts to regulate during high water might not have a fast enough response to the high water, but could aggravate a low water period following the high water. There is a major question as to whether forecasting could be improved enough to make actions effective.

FEMA UPDATES
DETERMINING THE 100-YEAR FLOOD RISK FOR THE GREAT LAKES

Mr. Norbert F. Schwartz
Federal Emergency Management Agency (FEMA)
Chicago, Illinois

WAVE RUN-UP STUDY

Presently FEMA maps only the Great Lake levels without wave run-up. We have 100-year maps for approximately 340 communities with A-zones (100-year) and B-zones (500-year). We do not include V-zones (wave run-up) or E-zones (erosion).

FEMA commissioned the Detroit COE in 1987 to undergo a three-part study for the Great Lakes:

1. Wave Run-up Reconnaissance Study (Complete 1987)
2. Develop a Wave Run-up Methodology (Initiated in May)
3. Apply the Methodology to National Flood Insurance Program (NFIP) Communities in Ranked Priority (Expect to Start in FY 90)

Reconnaissance: The purpose of the reconnaissance study was to provide information on the impact of wave run-up in the Great Lakes. Concern by FEMA about the present high Great Lakes water levels in conjunction with severe seasonal storms prompted the consideration of the addition of wave run-up into existing flood insurance studies and maps along the shorelines. FEMA needs to know the extent of the problem before we proceed with new zones and new maps.

The 100-year flood levels are based on storm water level which results from a wind setup superimposed on the undisturbed water level of the lakes. Very short-period fluctuations of water levels such as wave action are not considered nor is wave run-up considered.

The approach that was used was simple but time consuming. A list of communities was developed that included townships and counties which are participating in the NFIP and located on the Great Lakes. With the addition of Pennsylvania and New York, the total number of areas increased to approximately 340.

It was obvious that not all the flood insurance studies are affected by wave run-up. Therefore, an initial screening of the 340 communities was conducted. This first pass threw out those communities where existing shore-

line bluff conditions were greater than 10 ft high and where there was no apparent development at these sites. United States Geological Survey (USGS) quads, aerial photographs, coastal studies, and field trips were used for this screening step. This method reduced the number of Flood Insurance Study (FIS) restudy candidates to 109 communities. At the same time, data on existing shoreline conditions, bluff characteristics, types of material, land usage, and erosion and flooding problem areas were collected and stored.

In addition to the initial screening process, a community prioritization by means of a "density count per shoreline mile" was conducted for those remaining communities where aerial photography was available. This procedure consisted of overlaying the 100-year flood plain boundary on existing aerial photographs of the individual site studied. An estimate of the number of structures within this boundary was coded in a matrix format. The matrix also includes by community number of miles of shoreline and the density factor. The number of structures in the flood plain range from 0 to 1,430.

Methodology for Wave Run-up: Detroit COE will develop and test a methodology suitable for use on all the Great Lakes and connecting channels for the application of the wave run-up factor in the FIS. The final product will be submitted to FEMA in a format compatible for direct inclusion into the guidelines and specifications for study contractors dealing with the NFIP. Factors to be considered in the methodology will include: shoreline topography, near shore bathymetry, type and extent of shoreline protection and development, local gage data, design water and wave compilation, and any other data pertinent to fully describe hydrologic and hydraulic parameters.

Once a methodology is developed for representation of the physical characteristics of wave run-up, the probability of a given wave run-up must be combined with the combined effects of still water and storm surge levels and probabilities.

Application: The COE has estimated that on the average cost is approximately $15,000 per site to calculate the wave run-up and revise the FIS. The total cost for the revisions of the FIS reports to include wave run-up would depend on the number of potential sites selected by FEMA from the screened 109 communities. FEMA would use a V-zone designation for the mapped wave run-up areas.

OPEN-COAST FLOOD LEVELS

The Detroit COE is in the process of updating the publication entitled, "Report on Great Lakes Open Coast Flood Levels," dated June 1978. Specifically, the effort consists of deriving the 10-, 50-, 100- and 500-year open coast flood levels for the entire US shorelines of the Great Lakes using frequency curves of annual maximum instantaneous lake levels recorded at approximately 75 river and lake gages. Lake levels from 1900 to 1986 have been analyzed. Where appropriate, recorded lake levels will be adjusted to reflect present diversion and outlet conditions. A Phase II report presents methods for determining the frequency of flood levels at locations other than the open coast to include bays, inlets, shorelines protected by islands and the connecting channels.

A preliminary comparison between the findings of the 1977 report and the new study indicates that the new study has higher elevations for each of the reported reaches. The average and maximum difference of the new study's water levels from the original study's water levels for each lake are listed in slide 3. The difference in at least three of the Great Lakes is significant enough to warrant an elevation and map revision for the lake communities.

UPTON-JONES AMENDMENT

FEMA has been recently saddled with a new responsibility when Congress passed the Upton-Jones Amendment. The provision, which was signed by the President on 4 February 1988, amends the National Flood Insurance Act of 1968 by adding a new section. The amendment provides for the payment of claims under the NFIP Standard Flood Insurance Policy for insured structures "subject to imminent collapse or subsidence as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels."

Payments of claims under this provision are intended to be used for relocating or demolishing the structure. In order for future flood insurance coverage to be available on a relocated structure, the new site must be located landward of the area expected to erode during the next 30 years for one-to-four family dwelling units or 60 years for all other types of structures.

FEMA will make the final determination as to whether a structure, for which a claim has been submitted, is subject to imminent collapse. Initially, this process will require that the structure be condemned by a state or local authority and located within an area that is actively eroding.

FEMA intends to commission an investigation, through the National Academy of Sciences, to examine suitable methodologies for computing the erosion data that will be used in determining which structures are subject to imminent collapse and, therefore, qualify for a claim payment. After the methodology is established, erosion rate studies will be conducted and E-zones may be designated for the shorelines of the nation. In the interim, FEMA will rely on existing erosion rate data in making imminent collapse determinations and in establishing the 30- and 60-year setback limits.

DISCUSSION

In response to a question from Dr. Le Méhauté, Mr. Schwartz said that a cutoff would be needed on the wave heights used for determining the V-Zone, but they had not yet determined what they would use on the Great Lakes.

Dr. Nummedal asked if any claims had been filed yet under the Upton-Jones Amendment, and what direction that would take the program. Mr. Schwartz said that there have been some claims, and that FEMA was not in favor of the amendment. FEMA believes that the NFIP should pay for itself. He said that there is a provision in the amendment that you had to have flood insurance by 1 June 1988, in order to qualify.

Dr. Mei asked about the time schedule of the investigation. Mr. Schwartz said that it would take about a year and a half to have the methodology in a final form. They are planning to implement the methodology in FY 90.

In response to a question from BG Vander Els on the coordination of the work, Mr. Murdock said his office is working directly with Mr. Schwartz, and has been coordinating this since its inception.

Mr. Nuttle, in response to a question from Mr. Lockhart, said that initially they plan on using monochromatic waves to determine how much the wave run-up will add to the flood level. If they find that the monochromatic waves will not work, then they will go to spectral wave analysis. Dr. Mei said that he thought some additional research was needed to have a completely reliable wave run-up model.

Mr. Jannereth asked about the status of determining flood levels for embayments. Mr. Schwartz said that the report is in two phases. As restudy money becomes available, they will apply Phase II methodology, and they do intend to redo all the bays.

GREAT LAKES COASTAL FLOODING AND PL 84-99 ADVANCE MEASURES

Mr. Timothy J. Monteen
Chief, Emergency Management Division
US Army Engineer Division, North Central
Chicago, Illinois

The Advance Measures Program is an initiative begun by NCD in 1985 as a result of rising lake levels. Public Law 84-99 gives the Chief of Engineers discretionary authority to provide flood protection to protect against the loss of life and property. The intent of the program is to compliment the efforts of state and local authorities. The Corps' intent is to construct temporary, technically feasible projects. This is for flood damage only, and does not include erosion damage. The projects have a non-Federal cost contribution of 30 percent.

The Corps looked at approximately 190 sites on the Great Lakes, the majority being on Lake Erie. Because of its shallow depths, Lake Erie is more susceptible to storm-induced coastal flooding. The December 1985 storm produced a divergence in gage readings of 16 ft between Toledo, Ohio and Buffalo, New York; believed to be a record. When that set-up is added to a high lake level you get substantial flooding.

Two programs were initiated, one to construct temporary flood protection projects, and the other a self-help program. Eighteen projects were approved to date, with an approximate cost of $18 million. Expedient temporary structures included a rock crib structure, a sand crib which had a design similar to the rock crib, clay dikes, flashboards, steel parapet walls, and concrete parapet walls. There were some problems with aesthetics and access because homeowners wanted aesthetically pleasing projects and access to the water, even when they had record lake levels right at their doorsteps.

The Advance Measures Self-Help Program provided government furnished materials, including sand, sand bags, and plastic sheeting, to local communities and then provided training and technical assistance on how to build proper sandbag dikes. This was intended for back areas being subjected to flooding, and was not intended for areas directly exposed to wave attack. Forty-seven counties and 113 communities participated in this program. The Corps provided approximately five million sandbags, 30,000 cu yd of sand and

220,000 lin ft of plastic sheeting at a cost of $4.3 million. The program was well received by communities that were anxious to do something but were frustrated.

DISCUSSION

COL Lee asked about the present status of the structures.

Mr. Monteen said the structures were still in place. Local cooperation agreements require the communities to maintain them for a period of time, and to upgrade them if possible. Operation Foresight, in the '70s, did not have a requirement for maintaining structures, and many of them were torn down after serving their initial purpose. We would have been much better off during the recent high water levels if those structures had been maintained. The project costs during the more recent program were on the order of $10 million. During two storm events in December 1986 and March 1987, they prevented about $30 million in damages, so they are very cost effective. Communities paid 30 percent of the cost of the structures.

In response to questions about gabions, Mr. Monteen indicated they had been used previously in Operation Foresight, and they were found not to be as effective as other measures. They have a tendency to break up and are hard to maintain if they are subjected to direct wave action.

Dr. Mei asked about long-range plans to replace the structures.

Mr. Monteen said there were no plans under the Advance Measures Program. He said other avenues are available for permanent projects including Section 205 and other permanent continuing authorities, or congressionally authorized authorities. They presently have several Section 205 projects, and several Section 14 projects.

In response to a question from Mr. Henderson, Mr. Monteen reiterated that the Advance Measures Program was for flood protection only and did not include erosion projects.

GREAT LAKES WAVE INFORMATION STUDIES

Dr. C. Linwood Vincent
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US Army Engineer Waterways Experiment Station
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The Wave Information Study is a long-term Corps of Engineers project to develop a directional spectral wave climate for the US coastlines using state-of-the-art spectral wave modeling techniques. Historically, this study began with the calculation of a storm wave climate for the Great Lakes in the mid-1970's. The successful development of a spectral wave hindcast method for the Great Lakes served as a springboard for extending the technology to the other coastal regions of the United States. The current Great Lakes project is to compute a 30-year day-to-day wave hindcast climate to supplement the extreme waves climate formulated in the earlier study. Current activities include rigorous evaluation of the wind and wave models against measurements on the lakes. The production computer model runs will be made after verification is complete.

DISCUSSION

Dr. Vincent agreed with a statement by Dr. Nummedal that the Great Lakes are a much more constrained system than the oceans. In response to a question from Dr. Mei, he said that most of the Great Lakes are considered to be deep water, the exception being Lake Erie. Lake Erie would use a model that considers bathymetry because of the shallow depths. The shallow water model is more costly to run, so deep water models are used where possible.

Mr. Johnson said that the use of the original output from the wave information program saved North Central Division a large amount of time and effort, but it only included extreme wave estimates from given directions. It did not include data needed for cumulative long-shore wave energy. With the new information, he feels they will have a much better understanding of the processes. He also urged inclusion of a provision to quickly hindcast storms after they occur, as there is a major interest in what occurred during a storm.

THE CHICAGO LAKEFRONT

Mr. Henry L. Henderson
Chief Counsel
Chicago Shoreline Protection Commission

The City of Chicago enjoys a 30-mile shoreline along Lake Michigan. A full 24 miles of this is man-made, publically owned, and dedicated to public use and access. This is a unique public treasure, giving the City of Chicago one of the greatest expanses of public shoreline in the United States, and a resource that attracts visitors from around the world while it adds to the quality of life of its citizens immeasurably.

The lakefront of Chicago is the result of dedicated, visionary efforts of the City fathers. At the turn of the century, in an era notable for its celebration of private property and private enterprise, the City fathers of Chicago determined that the City would be strengthened and impoved if the waterfront of Chicago were dedicated to public use, access, and ownership. This vision was set forth most forcefully in the famous Burnham Plan of 1909, authored principally by the architect and city planner Daniel Burnham.

Following the publication of the Burnham Plan, the City followed a path of steady construction of shoreline parks, beaches, and harbors along the edge of Lake Michigan. Between the First and Second World Wars, more than $1 billion was invested in the Chicago shoreline, in the form of parkland and infrastructure such as the Shedd Aquarium, Adler Planetarium, and the Field Museum.

The value of the public shoreline remains unquantified. From a purely economic point of view, the aesthetic appeal of the park system has brought substantial benefits to the City. A recent study of this matter by real estate consultant Jared Schlaes indicates that a full 20 percent of the gross municipal product of Chicago is the direct result of the shoreline: land values, hotel fees, rental costs, and locations of businesses can all be shown to relate directly to proximity to the shoreline.

There is another value of the public shoreline of the City of Chicago that is initially invisible, and indeed hidden behind the cost of maintaining the shoreline: it is the value of the man-made shoreline as a flood and erosion protection device in an urban environment. When examined, it becomes clear

that the extensive parkland of the Chicago shoreline is an extremely cost-effective shoreline protection measure that deserves support and investment to maintain its integrity.

In the past three years, during the period of record high lake levels, the Chicago shoreline has sustained dramatic and obvious damage. Acres of public land have been washed away, important public structures have been threatened and damaged (roadways, buildings, and water works), and private development along the lakeshore has been flooded and damaged. In view of this litany of damages and the costs that they imply, the question arises as to whether the shoreline of an urban center like Chicago is not an extravagant expense rather than an economic resource.

The Chicago Shoreline Protection Commission, appointed last year by our late Mayor Harold Washington to advise him as to how best to respond to the threats to Chicago's lakefront from the high lake levels, considered this question carefully. After over a year of extensive public meetings and hearings, and extensive study involving Federal, state, and local authorities, the Commission concluded that the Chicago shoreline is a resource of immense social, economic, and aesthetic value, warranting public support from the Federal, state, and local governments. This conclusion rests in large part upon the unquantified value of open recreational space for the life of the region. There is a visceral appeal to this conclusion: intimate contact with the dominant natural resouce on the midwestern United States (the Great Lakes), from within one of the greatest urban centers in the world, Chicago, has a unique, obvious value. But, under the careful cost/benefit criteria of the Federal government, as represented by the US Army Corps of Engineers, this does not carry very far. The Chicago Shoreline Commission considers that the value of the Chicago shore can be successfully defended under Corps criteria as well. The Chicago shoreline, during the most furious storms of the past 3 years afforded a magnificent barrier to flooding and erosion for the literally billions of dollars of private developments that lie immediately behind the parkland. Absent this parkland, the ravages of the lake storms would be devastatingly expensive. The public lakefront has prevented this expense and itself deserves support for this service.

DISCUSSION

In answer to questions about the costs and funding sources, Mr. Henderson said that using a conservative cost methodology and looking at the high end gave a total cost of $843 million over a 10- to 15-year period. A projection of maintenance considerations is factored into the cost. He said they were looking at a package of funding sources; the present effort will be on getting both Federal and state assistance for initial work. They anticipate generating more money from lakefront development that would pay off development bonds and go back into shoreline projects. It is not anticipated that the projects could be supported within the tax base of the city or the park district, and funding from taxation would require an authority having a broader tax base.

Dr. Mummedal said that nearly $1 billion would be spent to put back what nature had originally provided, and pointed out the necessity in relatively undeveloped areas to implement setback lines now so that similar problems do not occur in other areas in the future.

Mr. Henderson said that a comparison could be made between the Edgewater area on the north side of Chicago, which had dense lakefront development and substantial problems, and the Rogers Park area, which did not allow the high density development of the lakefront and had minimal problems.

BG Vander Els asked about priorities.

Mr. Henderson said, given the complexion of the makeup of the commission, that they did not say particular projects needed fundamental priority. What determines what will be built first is what they can get funded first. Flood control projects will most likely go ahead of recreational enhancements. There is a commitment by the Commission, the City, and the Park District see that investment in substantial development and enhancement is equitably distributed. There is no question that the south side of the City is where equity lies first. Mr. Henderson agreed with BG Vander Els that further articulation is needed on the synergism to be gained from a consciously-arrived-at sequence of projects.

It was noted that this was not treated as just a lakefront issue, but as a city and regional issue. It is a major concentration of publicly accessible, freely open land. People have been very interested.

It was also noted that some future range of lake levels needed to be considered for planning, and a level 3 ft above the '86 level was used for cost purposes.

DYNAMIC EQUILIBRIUM AND SHORELINE RESPONSE TO FLUCTUATING GREAT LAKES WATER LEVELS

Mr. Charles N. Johnson
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Chicago, Illinois

Coastal structures may be static or dynamic. The armor units in a static structure are intended to be immovable by waves. Use of a static structure minimizes total material tonnage; but such structures are very unforgiving of toe-scour, avalanching, and loss of backfill. If armor units are displaced down the structure slope, nothing in nature can push them back up. In a dynamic structure the particles are allowed to move under wave action. The most common type of dynamic structure is a beach. Beaches may be made of any size material from fine sand up through grave, cobbles, and even boulders. Beaches have long been known to achieve equilibrium profiles determined by wave climate, water level, and particle settling velocity. This equilibrium is very stable. The steepness of the equilibrium profile increases with settling velocity. Drs. Per Bruun and Robert Dean derived a mathematical description of the profile, the now classic $Y=Ax^{0.67}$ function. This function predicts beach erosion with rising water levels and beach accretion with falling water levels.

In 1970, with CERC sponsorship, Dr. Richard A. Davis, Western Michigan University (WMU), established 17 profile sites along the eastern Lake Michigan shoreline. His intent was to make frequent surveys of these sites over a complete cycle of lake levels to better understand how the shoreline behaves under all water level conditions. Davis departed WMU in 1973, and since then the Corps (CENCE and CENCD) has been informally visiting these sites every year or so. The recent rise and fall of Lake Michigan's water level has enabled us to watch the shoreline responses at these sites. As water levels fell during 1987 there was substantial beach accretion at nearly all sites. This accretion is in accordance with the Bruun/Dean theory. The existence of an equilibrium, dynamic, beach profile has numerous implications for shoreland protection and management:

1. If enough beach material is present, a beach can adjust to and protect against waves at any water level.

2. Non-conservation of beach material is destructive.

3. Coarse materials provide beach-type protection with less material per lineal foot than do fine sands.

4. Coarse materials can establish a beach on a steep erosion-stressed slope much more easily than can fine materials.

5. Alongshore transport of coarse materials takes place closer to the water's edge than that of finer materials.

6. Almost no type of shore protection structure works well as beaches are carried lakeward when water levels rise. Almost all shore protection structures are engulfed in beach material as accretion takes place when water levels fall.

7. Interruption of the supply of gravel to a shoreline can be far more damaging than interruption of the supply of similar quantities of sand.

8. Shore erosion at extreme high water levels leads to wider beaches at all lower water levels. Therefore lake level regulation to reduce extreme highs may return little net erosion benefit.

9. The ability of the shoreline to adjust itself to fluctuating water levels is great. People should not put themselves in the path of the adjustment process by encroaching on dunes.

DISCUSSION

In response to a request from BG Vander Els, Mr. Johnson summarized the major conclusions which had been derived. They noted that as water levels went down, the beaches accreted, becoming wider. Material is carried back into the shoreline. They observed that coarse material provides more protection because it maintains a steeper beach slope, and much less material is needed to achieve equilibrium. However, it appears possible that interrupting a supply of gravel on a coarse beach can be far more damaging than the interruption of a supply of similar quantities of sand on a finer-grained beach.

It should be noted that beaches are inherently an erosional feature with very powerful processes, and the shoreline has the ability to adjust itself to fluctuating water levels. People should not put themselves in the way of these natural processes if they can at all avoid it.

MONITORING COMPLETED COASTAL PROJECTS
BURNS HARBOR, INDIANA

Mr. Charles N. Johnson
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Chicago, Illinois

The Burns Harbor, Indiana breakwater, located at lake bed elevations of -40 to -45 ft LWD, is at the extreme south end of Lake Michigan. Its armor material is 10- to 16-ton cut-stone oolitic limestone blocks randomly placed double layer on a 1:1.5 slope. It is a classic Shore Protection Manual type design, except that the harbor-side armor is single layer only from +3 to -13. Major problems associated with this breakwater are wave transmission and shore stability.

Permeable breakwaters inherently transmit coherent wave energy which may cause objectionable motions of moored vessels. Permeability may also be associated with the observed harbor-side armor damage incurred during the 8 February 1987 storm.

MONITORING COMPLETED COASTAL PROJECTS

Mr. Denton R. Clark
US Army Engineer District, Buffalo
Buffalo, New York

The Buffalo District has had two past projects in the Corps' Monitoring of Completed Coastal Projects Program, Cattaraugas Creek Small Boat Harbor and Cleveland Harbor East Breakwater Rehabilitation Project. A third project, Irondequoit Bay Small Boat Harbor, has been nominated for inclusion in the program.

Important concerns at the Cattaraugus project are structure stability, effects on the adjacent shoreline, and effects on flooding. A 3-ft bedding layer had been designated beneath the breakwaters, but the contractor had held the top of the bedding layer to one elevation, so that in some places it was as much as 7 ft thick, and there was concern that the excessive thickness would be susceptible to wave action. At the termination of monitoring, that instability had not occurred.

There had been an initial expectation of beach erosion on the downdrift side of the harbor, which would have required sand bypassing, but monitoring has shown that did not occur.

The mouth of Cattaraugus Creek has a long history of flooding because of ice jams. It was anticipated that construction of the project would eliminate shoaling which had contributed to the ice jams. However, the ice jams still occur, even though the shoaling was eliminated. At this time the problem has not been solved, and flooding still occurs.

The Cleveland Harbor breakwater rehabilitation consisted of repairing 4,400 lin ft at the east end of the breakwater with 2-ton unreinforced dolosse. The head section of the rehabilitation was basically the same design as the trunk, except that the slope was slightly flatter, being 1 vertical to 2.5 horizontal. Broken dolosse have occurred every year since construction, and the structure head has been especially susceptible to damage. Considerable damage has occurred to the breakwater head during storms in April 1982, December 1985, and February 1987. After the last storm, the structure head was repaired using larger units, and a total of 350 modified 4-ton dolosse were used.

Coastal structures at Irondequoit include a rubble-mound, shore-attached breakwater on the west side of the entrance channel, and a rubble-mound jetty on the east side. There has been no formal monitoring, but through routine dredge soundings, a very large scour hole was discovered during September 1987. The scour was not present in previous soundings in May 1986. It seemed the entire breakwater structure would be threatened. An emergency remedy was to place 6,000 tons of leftover stone in the hole. At this time, it is not known what caused the scour hole.

DISCUSSION

In response to a question from Dr. Nummedal on harbor entrance shoaling at Catarraugus Creek, Mr. Clark said that sediment builds up, but the spring flows blow it out. They have not had to dredge since the project was completed.

BEACH NOURISHMENT - OBJECTIVE, DESIGN, RESULTS

Mr. Thomas C. Nuttle
Chief, Coastal Engineering Section
US Army Engineer District, Detroit
Detroit, Michigan

The Great Lakes shoreline has a glacial or lacustrine origin. Present shore formations indicate an extensive variation in lake levels during the glacial era. The existence of steep high clay or sandy till bluffs along the Great Lakes shorelines is associated with long-term patterns of wave erosion and shore recession. Most of the material composing sand beaches fronting lake bluffs is supplied by wave erosion of those or updrift bluffs. Rising lake levels in recent years have severely inundated protective beaches, causing considerably accelerated erosion rates.

OBJECTIVE

Harbor structures such as jetties and breakwaters form near total barriers to sediment transport. Their impact on downdrift shorelines is to increase erosion and related dune-bluff recession as a direct result of longshore sediment transport reduction. Sediment is removed from nearshore bars on the downdrift side of harbors, causing a gradual degradation of protective bar systems. The only natural way to mitigate navigation structure impact on downdrift shorelines is to replenish material lost to sediment transport systems because of blockage by navigation structures.

The objective of beach nourishment placed by us is to restore that portion of littoral drift interrupted by navigation structures. It is not intended to provide mitigation measures for natural erosion, and does not approach the extent of protection usually provided by beach erosion control projects. Therefore, the usual structural solutions such as seawalls, bulkheads, revetments, breakwaters, groins, and similar shoreline stabilization structures are considered beyond the scope of work needed for mitigation of erosion from navigation works.

DESIGN

Two engineering techniques are usually used for replenishment of material lost to the transport system due to blockage by harbor structures, sand bypassing, and beach nourishment. Sand bypassing mechanically transports material from the updrift fillet to the downdrift erosion zone. The major concern in applying this technique is finding material which is suitable for both engineering design and environmental considerations. Beach nourishment, which has often been found to be more suitable, forms protective beaches and replaces littoral materials blocked by navigation structures. After determining beach nourishment volume requirements, the optimum fill material for nourishment sites at many Great Lakes locations has been found to have a mean grain size of approximately 3 mm. To function as a stabilized protective beach, fill material must be stable at the water's edge. Coarse beach material tends to be pushed landward during storms, and fine beach material carried lakeward in suspension by wave action. On-shore borrow sites have been found at most locations to satisfy volume and gradation design requirements.

RESULTS

Feeder beaches and periodic nourishment provided to maintain them and dissipate wave energy have adequately mitigated and prevented shore erosion attributable to Federal navigation structures. Restoration of littoral drift however, does not completely eliminate erosion. The effects of wind and wave action, violent storms, rising lake levels, bluff drainage problems, and the natural erosion process continue. Beach nourishment which we have placed mitigates erosion attributable to navigation works. It is not a substitute for a beach erosion control project. It provides equitable and justified remedial measures for navigation structure induced erosion. A need remains yet however, to improve our understanding of fill performance and the physical laws associated with it. Consequently, a series of experiments are planned along the shores of eastern Lake Michigan to supplement presently available knowledge on beach fill performance.

EXPERIMENTS

Field experiments are scheduled to be conducted along the Lake Michigan shoreline jointly with WES, NCD, Great Lakes Environmental Research Lab, Michigan Department of Natural Resources, Purdue University, University of Michigan, Ohio State University, and others during September 1988. Data on sediment transport, waves, nearshore processes, and beach nourishment will be obtained. The purpose of the experiments is to obtain field data and an increased understanding of beach fill behavior to improve fill designs and performance.

DISCUSSION

Dr. Mei commented on the sandbars that occur in some areas. He feels that the bars can act as strong reflectors of wave energy, and the reflection processes can also cause a tendency for bars to remain providing more protection.

Mr. Nuttle said the bars are very prominent along the sandy Michigan shoreline, but he does not see them, in his experience, along other types of shorelines.

Dr. Le Méhauté commented on his past experience working on the Lake Michigan shoreline. He said that the rate of erosion has a periodicity. It's not the same from place to place. The only explanation that he could find was that there is a network of standing edge waves which reflect back and forth between navigation works. He calculated them to have a period of 4 to 5 min. He asked if the Corps had made any observations on that type of phenomenon.

Mr. Nuttle said he was inclined to agree that such phenomena exist because they see traces of the edge waves due to the beach cusps that can be seen in the vicinity of harbor structures.

NORTH CENTRAL DIVISION RESEARCH NEEDS

Mr. Zane M. Goodwin
Chief, Engineering Division
US Army Engineer Division, North Central
Chicago, Illinois

Thank you for the opportunity to discuss the progress on North Central Division's research needs. As you may recall, we presented our research needs at the CERB meetings in December 1984 in Chicago and again in May 1987 in Corpus Christi.

Our research needs reflect our heavy work load in operating and maintaining over 120 harbors on the Great Lakes. Between 1984 and 1987, we were experiencing the highest water levels in the Great Lakes in this century, and our concerns reflected problems associated with high levels. Since the spring of 1987, the lake levels have abated dramatically, and by mid-summer this year we predict that Lakes Michigan and Huron will be about 1-3/4 ft lower than the levels for a similar period in 1986. The current forecasts shows Lake Michigan will only be about 9 in. above its long-term average this summer. All of the Great Lakes will be no more than 1 ft above their long-term average, and Lake Superior will probably be slightly below its long-term average level this summer.

These declining water levels have resulted in the dramatic return of most of our beaches and have provided some answers to some of our questions such as; does the Bruun effect apply on the Great Lakes? This period of lake level fluctuations has presented a unique opportunity to observe the effects of fluctuating lake levels and shore response. The steady decline of lake levels from the October 1986 high to early spring 1988 has been a period of great readjustment of many miles of Great Lakes beaches.

I want to discuss the developments which have occurred since we listed our research needs with this Board in 1984 and 1987:

1. Quickie Model Tests, mentioned in 1984 and 1987.
2. Verify the Hypothesis that Rising Lake Levels, Not High Levels, Accelerate Recession Rates.
3. Use of the Kitaigorodski Wave Theory for Structural Design.

4. Establish Offshore Breakwater Freeboard Versus Beach-Planform Relations.

5. Establish the Importance of Beach Fill Particle-Size to the Operation of Groins.

6. Information on Stress Levels for Dolosse.

7. Modeling Waves in Harbors.

8. Stability Problems of Breakwaters Due to Wave Transmission.

9. Berm Breakwaters and Jetties.

10. Surf Zone Sediment Transport Processes.

As we review the research needs we presented in 1984 and 1987, we are satisfied that progress is being made on most of these needs. We have had discussions with CERC on the research needs not yet in any program, and we are pleased with the CERC attitude in providing assistance to meet our research needs. We intend to keep open the channels of communication with CERC and the R&D Technical Monitors at OCE to ensure our research needs are being met.

There is one additional item I would like to mention. Due to the rapid increase in the capability of the PC's which are becoming abundantly available in our offices, we would encourage the ACES Committee to consider developing new programs to better utilize the capability of new PC's.

DISCUSSION

In response to a question from BG Kelly, Mr. Goodwin said that "quickie model tests" were tests that could be set up very rapidly, as opposed to models which are very precisely constructed. It can be done efficiently for certain types of models. The problem has been finding available facilities. CERC has some facilities that have been used before for this type of application.

Dr. Houston said that CERC tries to respond rapidly to District needs, but some facilities are in heavy use at certain periods of time. He added that you have to be careful in using this type of test; for some applications such as preliminary planning of a study, they may be fine, but for actual project design, you could get a wrong design.

Dr. Nummedal said that he was pleased to see the close coordination and correlation between the research objectives as formulated by the North Central Division, CERC, and the civilian research community with respect to the Great Lakes.

Mr. Goodwin concurred with Dr. Le Méhauté that the scale effect in regard to wave transmission can have an effect on studies. This points out the importance of having a very large wave tank. Reference was made to the previous discussion on wave transmission problems at the 47th CERB meeting in Corpus Christi, Texas. In response to a question from BG Kelly, Dr. Houston and Mr. Chatham pointed out that wave transmission can occur anywhere, but that the Burns Harbor breakwater previously mentioned by North Central Division had a unique design that may contribute to the problem. The high lake level may have also contributed to the problem. There is a proposed work unit to look at this type of problem, but it has not been funded.

Dr. Le Méhauté noted that the Los Angeles-Long Beach model took wave transmission into account by calibrating the scale model. BG Kelly noted that one of the objectives in the Los Angeles-Long Beach model is wave transmission, and the next major objective would be big ship movement.

Dr. Houston said that Los Angeles-Long Beach Harbor has problems with long waves that cause ship surging motions, and that CERC was involved in extensive studies to try to understand that phenomenon and help future designs.

Mr. Lockhart mentioned the desirability of looking at conditions that exceed the design condition when running model tests. That can account for potential problems in advance.

There was some discussion about the typical period of waves transmitted through breakwaters. Longer period waves are more readily transmitted. At Burns Harbor there were transmitted waves with periods of 10 to 11 seconds. It is also quite common for waves with periods of 6 to 8 seconds to be transmitted through the breakwater. Longer period motion may be induced in moored ships. It was pointed out that the ship's mooring system is a major factor in the natural frequency of oscillation of the vessel.

PANEL

COASTAL R&D ON THE GREAT LAKES - PRESENT/FUTURE

Dr. James R. Houston, Moderator
US Army Engineer Waterways Experiment Station

Dr. Keith W. Bedford
Ohio State University

Dr. Guy A. Meadows
University of Michigan

Dr. William L. Wood
Purdue University

Dr. Bedford stated that the areas of research activities at Ohio State University can be summarized by the fundamental role that measuring, parameterizing, and predicting sediment effect have on CE coastal engineering activities. Recommendations for future research stem from these activities. Considerable progress in the development of integrated circuitry over the last few years has led to a variety of new procedures for measuring sediment entrainment and visualizing the transport of sediment through remotely acquired acoustic and satellite transducers. The development of these technologies for use in coastal process and engineering studies is the central goal of the research program. Research to be briefly summarized includes: acoustic instrumentation for direct entrainment and in situ grain size measurement; improved acoustic methods for surveying and parameterizing bottom erosion susceptibility; the effect of seiches and storm surges on sediment sorting, entrainment, and deposition in Great Lakes navigable harbors; and a brief overview of turbulence modeling based procedures for making harbor, estuary, and nearshore sediment transport calculations. Recommendations for future research are motivated by the author's belief that the management questions being asked and the modeling and analysis tools being brought to bear on these questions require high quality data that simply cannot be measured at this time. Therefore, the development of new precision in situ instrument technologies are of utmost importance. Further, the application of these technologies to sediment transport problems in harbors and adjacent nearshore zones should receive primary attention.

Dr. Meadows said the Great Lakes encompass over 9,000 miles of coastline, and the Great Lakes basin provides a home to 15 percent of the US populations and 50 percent of Canada's population. Of the entire Great Lakes shoreline, 83 percent is privately owned land, valued between $100 and $1,000 per lin ft. Fluctuations in Great Lakes water levels have resulted in large losses along the Great Lakes shorelines. A US Army Corps of Engineers study indicated that during the high-water period of 1972-76, an estimated $170 million was spent on private shoreline protection structures, while $231 million of property (land and structures) loss occurred.

The third, and most recent, occurrence of record-setting high lake levels during this century (1985-1986) and the resultant severe storm damage throughout the Great Lakes region have once again pointed to the need for an increased understanding of coastal processes and the response of coastal engineering structures to minimize losses and plan effectively for the future.

The goal of the Ann Arbor Workshop on Great Lakes Coastal Erosion Research Needs was to bring together researchers and administrators in the Great Lakes region to increase awareness of Great Lakes coastal engineering research, increase communication among the researchers, and to identify, as a group, research needs and the roles that each organization can play in contributing to a better understanding of the coastal environment. Five working groups were designated to direct efforts towards identifying research needs in the following areas:

Field Experimentation
Baseline Data Collection
Analysis of Existing Data
Instrumentation
Numerical Modeling

The workshop recommendations presented below reflect the need to advance the understanding of coastal responses to process and trends in the nearshore environment and to improve prediction and analysis techniques.

FIELD EXPERIMENTATION

Problem: The lack of information about Great Lakes coastal processes requires that major field studies be undertaken.

BASELINE DATA COLLECTION

Problem: To adequately verify numerical modeling and analysis techniques, comprehensive baseline data collection guidelines and programs must be initiated to provide spatial and temporal coverage necessary.

ANALYSIS OF EXISTING DATA

Problem: There is a vast pool of existing data that should be tapped to lend insight to coastal engineering research.

INSTRUMENTATION

Problem: An important step toward the understanding of any coastal process is the accurate and efficient measurement of its physical parameters. Deficiencies presently exist in the available bathymetric data, shallow water directional wave information, sediment transport measurement capabilities, and portable data acquisition systems.

NUMERICAL MODELING

Problem: Agencies involved in evaluating structures and their effects on the adjacent shoreline need to be able to predict sediment transport and shallow water waves, particularly in response to climatological events.

As a result of the Ann Arbor Workshop on Great Lakes Coastal Erosion Research Needs, several of its recommendations have already been realized:

1. CERC and the University of Michigan have cooperatively brought the first semi-permanent installation shallow water directional wave gage to the Great Lakes.

2. CERC and a Great Lakes multi-university team are working to organize and conduct a preliminary, coordinated Great Lakes Coastal Processes field experiment during Fall 1988 and an extensive field experiment during Fall 1989.

3. Through a multi-agency effort, a Great Lakes Field Research Facility is developing at Big Sable Point Lighthouse, on Lake Michigan.

4. The State of Michigan has funded the establishment of 45 permanent nearshore survey lines along Lakes Michigan and Huron shorelines to monitor the nearshore adjustment process following record setting lake levels.

These activities represent only a first step toward the severe coastal engineering problems existing on our nation's largest and most densely populated coastline.

Dr. Wood said there are four major areas requiring immediate investigation in the Great Lakes:

Coastal Kinematics and Hydrodynamics
Coastal Processes
Engineering Structure Performance
Coastal Evolution

Highest priority should be given to a large-scale field experiment integrating coastal kinematic and dynamics measurements with coastal process monitoring. Engineering structure performance, involving both existing site-specific structures and prototype generic structures, should be evaluated under conditions of varying lake levels. Rising lake levels produce a number of obvious engineering problems, but falling lake levels also create problems with shoreline adjustment, structural overtopping, and harbor and coastal navigation. There is a strong need for better understanding of Great Lakes coastal evolution as evidenced by recent indications of long period cycles of lake advance and retreat. Two evolutionary components are of major interest to contemporary coastal engineering problems: natural sediment deposition/erosion trends and verification of long-term lake level changes.

DISCUSSION

Dr. Nummedal reiterated Dr. Meadows' statement on the importance of analyzing existing data. There was some discussion on research that has previously been carried out on ice effects on sediment transport; the oil industry has looked at this in Arctic Alaska.

In response to a question about onshore sediment transport with falling lake levels, Dr. Wood pointed out that it is a matter of perception. People do not always have a very good reference, and they see the beach getting

wider. In reference to where the shoreline actually is, you are only regaining about 20 percent of the profile. There is not a good understanding at this point of the actual rebuilding process. Sand may move offshore beyond the zone of recovery, but sand could also be carried off in the longshore direction.

Dr. Le Méhauté agreed that a lower lake level may induce a temporary readjustment of the beach profile, which gives an impression that the shoreline is accreting. He thinks this is only temporary, and it needs to be made clear to the public that erosion is continuing. He concurred that the biggest gap in understanding sediment transport is a lack of understanding of turbulence; and the key is the development of instrumentation.

There was some discussion about the principal control on vertical stratification in Sandusky Bay. The general conclusion was that no one knows what it is.

There was discussion on the related research work in other agencies, and the interaction with the Corps' North Central Division. Mr. Goodwin said that there is a lot of ongoing work in climatology not only at NOAA's Great Lakes Environmental Research Lab, but also at Canadian agencies and other agencies of the US Government. Most of it seems to deal with the effects of increasing the carbon dioxide content of the atmosphere, and the most prevailing opinion seems to be that this will increase the frequency of low lake levels. It is predicted that precipitation will increase, but this will be more than offset by increased temperatures that will increase evaporation over the Great Lakes basin. There has also been research on past flucuations that show historic lake levels several feet higher than those observed in this century.

BG Vander Els said that one of the conclusions he had drawn from the Board meeting was that there is a lot more going on in academia, and in other government institutions, that could bear on Great Lakes problems. He asked to what extent we should be trying to strategize those efforts, in particular with regard to practical applications on problems where tens of millions of dollars are expended every year, and to avoid some mistakes that evidently have been made with regard to types of structures that tend to exacerbate problems.

The state of the art of instrumentation was discussed. Dr. Bedford feels we should be pursuing opportunities to build new instruments. He said the development of instruments is often somewhat haphazard on an as-demand basis as projects require it. As an example of new instruments he mentioned an accoustics tomography system that was developed over a period of about 10 years, in spite of many obstacles, that was deployed the previous winter in Lake Ontario as part of a wave study. By using that instrument, they obtained information on the surface wave current field that was completely different from what people had hypothesized in published literature. It will have a major effect on surface wave research.

PUBLIC COMMENT

Mr. McCann raised a question about the relationship between levels of damage and increases of water level. Also, he asked if the damage level experienced on the Great Lakes was peculiar to the Great Lakes because of their special characteristics, including seiches, or whether those same damage levels would occur on the ocean coastline.

There was discussion of the damage level associated with a 1-ft rise in water level. Dr. Nummedal pointed out that the problem on the Louisiana coastline has been a loss of wetlands; with a 1-ft rise in sea level over the last 20 to 25 years, they are losing wetlands at a rate of about 60 square miles per year. He feels that a 1-ft rise on an ocean shoreline actually causes considerable more damage.

Mr. Keillor said the impact of a 1-ft rise depends on the particular facility. A Milwaukee Harbor engineer equated a 1-ft rise to $2 million in damage to cargo piers. In Duluth, increased levels were equated to shutting down the harbor. Various key facilities such as docks, sewage treatment plants, and water intake structures all have levels of damage associated with increased levels. They don't really know at what point harbors become inoperable.

Mr. Keillor also addressed the need for research, and feels more research is needed on recent prehistoric lake levels and evidence of past climatic variability in the region. There should also be more research on extending lake level forecasting and climatological forecasting. There is some evidence that extensions of present modeling could lead to forecasting lake levels with probabilities up to a year in advance. Some work on climatological forecasting was discontinued because of a lack of interest from funding sources.

COL Harris spoke on behalf of COL Benjamin C. Shapla (retired) who was unable to attend, and expressed COL Shapla's appreciation for the CERB meeting on the Wisconsin shore of Lake Michigan, and the recognition of the sensitivity of that shore and the need for scientific solutions to the erosion problem.

FINAL DISCUSSION AND RECOMMENDATIONS

Dr. Nummedal referred to BG Vander Els' previous statement about strategizing research. He said the beginning of this was exemplified well in the experiments at CERC's Field Research Facility at Duck, North Carolina. The Duck '85 and SUPERDUCK experiments were great successes and clearly of great value to the Corps. The Great Lakes experiments for '88 and '89, which are jointly sponsored by the Corps of Engineers and the Sea Grant Programs of the states involved, will be similarly successful joint ventures. He recommended that style of interaction in the future. He suggested that this could be extended to other programs, such as Monitoring Completed Coastal Projects, to make use of expertise in the private sector. It is clearly important for the Corps to continue research, but it's equally important to ensure that knowledge is transferred effectively to users.

Dr. Nummedal strongly supported development of the WES Graduate Institute. He also supported the continuing development of PROSPECT courses for District personnel.

Dr. Nummedal said that the Chicago lakefront projects demonstrate the enormous value of open waterfront property. The willingness of the citizens of Chicago to invest nearly a billion dollars makes it quite clear that people in general do put a high value on that zone of land. He mentioned that Norway passed legislation about 20 years ago that requires a setback line along their entire coastline of about 400 feet. Norway has an emerging coastline that is not eroding. The reason for the setback is free access. He thinks that it is important to encourage people to build back further from the shoreline. While an area is lightly developed, the coastal zone could be designated as a public area and would serve as a buffer against storms.

Dr. Le Méhauté said that the most important advance which occurred during his tenure on the Board was costsharing. It will have a profound effect on the way we have to operate. State and local authorities will have to build up their own capability in coastal engineering. It will be positive in that it will stimulate and enlarge the profession. However, each state will have its own view of each problem; they will not have the same set of regulations and the same set of values. The Corps will have to learn to work with the state and local people.

Dr. Le Méhauté foresees the coastal population increasing to three or four times its present level and does not consider it realistic advocating a retreat from the shoreline. He agrees with the need for a buffer zone along the shoreline but feels it will be much more difficult to obtain this. He sees an increasing demand for coastal engineering and foresees more demand for moving into the sea by offshore construction. He feels that the coastal R&D budget is much too small in relation to the billions of dollars worth of coastal expenditures for flood insurance, dredging, coastal construction, etc. and estimated the R&D budget as approximately one-tenth of one percent of the total coastal budget. He thinks that money invested in coastal R&D will have a large payoff.

Dr. Mei focused his remarks on the educational initiative undertaken by WES and CERC. He feels that the WES Graduate Institute and the Masters of Engineering program are a good start which will benefit the coastal engineering profession at large. CERC is now offering its unique strength in modeling capabilities, its intimate association with practical problems, and its unique field facilities to coastal engineering education. He feels that existing coastal engineering programs at universities are primarily concentrated on basic processes and basic understanding, that their transfer of knowledge to coastal engineering is relatively small, and their capabilities of doing field studies and model studies are also far inferior to those now in existence at CERC. He thinks that CERC's contribution to coastal engineering education is going to be tremendous. He reiterated his thoughts that the program should be broadened in the future in the following ways: first, expanding the program into a yearly program; secondly, opening the program to non-Corps candidates from private industry, other universities, and foreign countries; and thirdly, extending the program to include several other universities in the WES Graduate Institute. He feels that it would be useful to have some strong incentives to attract outstanding US students into all graduate programs. He suggested fellowships designated to coastal engineering.

BG Vander Els said that he feels the CERB meeting demonstrated that there is a lot of research going on, a lot of problems that need to be dealt with, and a very real sense of urgency to concentrate efforts in both research and engineering development in this part of the country. He has a problem now related to Lake Ontario and the St. Lawrence River. He has a need for models, particularly updating the hydraulic models used in regulating the Great Lakes. In regard to education, he thinks the education of young Corps of Engineers' officers has probably been neglected in this area. Considering areas of interest, he feels one of the things North Central Division is most interested in is beach evolution under seasonal and lower frequency, large fluctuations of levels, because that affects their structures and much of their dredging and maintenance work.

BG Kelly said he was pleased that the meeting provided him with a comprehensive view of the Great Lakes and its water resource problems. He feels it was important getting the views of a US commissioner of the International Joint Commission, and Mr. Cuthbert, the representative from Environment Canada provided insights into their feelings. He complimented WES and CERC on the fast turn-around in putting together a Masters of Engineering program, with emphasis on coastal engineering. He said we need to ensure the Districts are aware of the potential savings using the ACES programs. These will provide 20 to 30 percent savings in both time and dollars in the planning process, and that has yet to be extrapolated into engineering.

BG Kelly complimented Mr. Goodwin for an excellent job on presenting the research needs of North Central Division. That was complimented by the panel on research needs, and BG Vander Els gave a focus and general summary on the need to strategize that R&D effort and the technical transfer from the Corps of Engineers' perspective. He noted that there is a lot of existing data that we need to find and utilize what we have. There will be a Great Lakes '88 field experiment, and he complimented North Central Division and CERC for laying out that program for '88 and '89.

CLOSING REMARKS

BG Kelly thanked BG Vander Els and COL Harris for hosting the meeting. He thanked the staff of Detroit District, particularly Roger Gauthier, who was the primary coordinator and made the necessary arrangements to put the meeting together, and Dave Schweiger who assisted in running the administrative portions of the meeting. He was particularly pleased with the field trip, and expressed his thanks to Messrs. Ron Erickson, Steve Running, and Tom Deja. He thanked CPT Don Gibbons, Messrs. Glenn Cunningham and Tony Francisco for assistance with transportaion, Mses. Sandra Watson and Debra Benson for assistance with registration. He expressed special thanks to Messrs. Dennis Rundlett for his photography during the meeting, Bill Gilliam for his visual aid assistance, and to Ms. Dale Milford, the court reporter. BG Kelly expressed special appreciation to Ms. Sharon Hanks for overall coordination and administration of the meeting.

The 49th meeting of the CERB was adjourned.

APPENDIX A
BIOGRAPHICAL DATA

DR. KEITH W. BEDFORD

Dr. Bedford obtained his Ph.D. from Cornell University in 1974 and has been in the Civil Engineering Department at Ohio State University since that time. He has been a Professor since 1982, Director of the graduate program in Coastal Engineering since 1983, and Director of Engineering and Science Research for Ohio Sea Grant since 1978. Dr. Bedford is a member of the governing board of the International Association for Great Lakes Research and Chairman of two ASCE Committees, including one on Turbulence Modeling in Hydraulic Computations. Research interest include the development of acoustic instrumentation for in situ entrainment, resuspension and analyses in estuaries, harbors and tributaries. In 1986, Dr. Bedford received the Huber Award from the American Society of Civil Engineering for research in these areas and received Senior Research Awards from Ohio State University in 1982 and 1988.

LEO J. BREIRATHER

Mr. Breirather is a retired Director of Education from Region 10, International Union UAW. He is past Chairman of the Great Lakes Coalition (GLC), Wisconsin Lake Michigan Shoreline Chapter (LMSC), and a member of the Board of Directors of GLC. He is presently on the Board of Directors of GLC Wisconsin LMSC and has resided on the shore of Lake Michigan in the town of Wilson, Sheboygan County, Wisconsin. His interest in promoting water level regulation in all of the Great Lakes was prompted by an expenditure of almost $35,000 for the erection of a seawall, buffered by tons and tons of quarry rocks to prevent his home from being absorbed by the high wave action during the period of record-breaking high water levels during the mid 1980's.

DENTON R. CLARK, JR.

Mr. Clark is Chief of Buffalo District Coastal Engineering Section. He has a Bachelor's degree in Civil Engineering and has been with the Buffalo District since 1963, with his first 8 years spent in the Hydraulics and Hydrology Branch. The following 2 years he spent in the Beach Erosion Section

which was in the Planning Branch at that time. Mr. Clark has been in the Design Branch for 15 years and Chief of the Coastal Engineering Section since 1976.

DOUGLAS R. CUTHBERT

Born and raised on the Canadian shores of the Great Lakes, Mr. Cuthbert's earliest impression of the power of water was a first hand experience with the Hurricane Hazel flood of 1954 in which 81 lives were lost in the Toronto area. His interests in water activities subsequently led him to Bachelor's and Master's degrees in Civil Engineering at Ontario's University of Waterloo.

Following work experiences for private engineering consultants including field experiences on the Great Lakes shoreline as a member of shore survey crews, Mr. Cuthbert joined the Federal Government of Canada and was posted to Ottawa in 1969.

Over the next 10 years he worked for Canadian water resource and marine engineering agencies on water projects across the continent including the Great Lakes.

In 1979, he moved to Environment Canada in Burlington, Ontario, and became heavily involved in Federal/Provincial water resource programs as well as Great Lakes water issues under the jurisdiction of the International Joint Commission (IJC).

More recently, he has held assignments as the Canadian Chairman of the International Niagara River and Lake Superior Boards of Control and is a member of the international management team responsible for the current IJC study on Great Lakes levels.

ZANE M. GOODWIN

Mr. Goodwin is Chief of the Engineering Division, US Army Engineer Division, North Central, a position he has held since May 1979. Prior to assuming this position, he served as Chief of both the Design Branch and the Engineering Division, US Army Engineer District, Norfolk. Mr. Goodwin has also served in the Albuquerque District with the Corps of Engineers' Ballistic Missile Construction Office field offices in Roswell, New Mexico (Atlas F),

and Sedalia, Missouri (Minuteman). He received a B.S. degree in Civil Engineering in 1953 and an M.S. degree in Water Resources in 1976 from the Univeristy of New Mexico. Mr. Goodwin is a registered professional engineer and land surveyor, a member of the American Society of Civil Engineers, and a member of the Senior Executive Service.

HENRY L. HENDERSON

Mr. Henry L. Henderson is Chief Counsel and Staff Director of the Chicago Shoreline Protection Commission, a 25-member body appointed to advise the Mayor of the City of Chicago on the future protection and development of the thirty-mile Lake Michigan shoreline of Chicago. He is Senior Attorney and head of the newly formed Environmental Division of the City of Chicago's Law Department. From 1985 to 1987, Mr. Henderson was Attorney General for the State of Illinois in the Environmental Control Division. In 1984, he was Aide and Special Assistant to Senator Paul Simon of Illinois. Prior to that, he was engaged in the private practice of law, specializing in commercial litigation. Mr. Henderson has a law degree from Washington University in St. Louis, Missouri. He holds graduate degrees in philosophy and theology from the University of Chicago and Oxford University and received a B.A. from Kenyon College in Ohio.

DR. JAMES R. HOUSTON

Dr. Houston is Cnief of the Coastal Engineering Research Center (CERC) of the US Army Engineer Waterways Experiment Station (WES). He has worked at WES since 1970 on numerous coastal engineering studies dealing with explosion waves, harbor resonance, tsunamis, sediment transport, wave propagation, and numerical hydrodynamics. He is a recipient of the Department of the Army Research and Development Achievement Award. Dr. Houston received a B.S. degree in physics from the University of California at Berkeley, an M.S. degree in physics from the University of Chicago, an M.S. degree in coastal and oceanographic engineering, and a Ph.D. in engineering mechanics from the University of Florida.

MARTIN R. JANNERETH

Mr. Jannereth has 14 years of experience in Great Lakes erosion areas in Michigan. He has been head of the Shorelands Management Unit for 10 years with responsibility for implementation and administration of the Shorelands Protection and Management Act which includes Great Lakes high risk erosion areas, flood risk areas and environmental areas (areas necessary for fish and wildlife). He is also responsible for providing technical assistance to property owners on shore protection and other erosion area management alternatives. Mr. Jannereth obtained a B.S. degree in Forestry and an M.S. degree in Forest Ecology from Michigan State University.

CHARLES N. JOHNSON

Mr. Johnson is a hydraulic engineer in the Coastal and Geotechnical Section, Engineering Division, US Army Engineer Division, North Central (NCD), where he has been employed since 1974. Prior to coming to NCD, he was a hydraulic engineer in the Detroit District. Mr. Johnson earned a B.S. degree in aeronautical engineering from the University of Colorado (1963) and an M.S. degree in civil engineering (hydraulics and hydrology) from the University of Texas at Arlington (1972). He is a registered professional engineer in the State of Illinois.

DR GUY A. MEADOWS

Dr. Meadows received his B.S.E and M.S.E. degrees from Michigan State University and his Ph.D. from Purdue University in 1977. His Ph.D. research focused on a field investigation of the spatial and temporal structure of longshore currents. This and related coastal engineering topics have remained his primary areas of research focus since joining the University of Michigan faculty in the Department of Atmospheric and Oceanic Science in 1977 and the Department of Naval Architecture and Marine Engineering in 1985. Dr. Meadows is the Director of the University of Michigan Ocean Engineering Laboratory.

Dr. Meadows' teaching activities involve graduate courses in applied ocean physics, coastal dynamics and sedimentation, and remote sensing of ocean dynamics.

Research topics while at the University of Michigan have included the mathematical modeling of waves, currents and shoreline evolution, synthetic aperture radar sensing of ocean dynamics, development of in situ and remote oceanographic instrumentation and data acquisition systems, and field experimentation and analysis of coastal oceanographic data. These activities have involved field investigation on both ocean and Great Lakes coastlines as well as the current Great Lakes shoreline monitoring program sponsored by the State of Michigan Department of Natural Resources.

TIMOTHY J. MONTEEN

Mr. Timothy Monteen is a native of Kenosha, Wisconsin. He received a B.S. degree in Civil Engineering from Marquette University in 1971. After graduation, Mr. Monteen accepted a job with the Corps of Engineers' Chicago District as an engineer-in-training. Following his 18-month rotational training assignments, he selected a position in the Operations and Maintenance Branch, Operations Division, performing a variety of civil engineering work related to the Illinois Waterway, Illinois and Fox Rivers, Wisconsin. Mr. Monteen was appointed to a dual position, Assistant Chief of the Construction-Operations Division and as the Emergency Operations Manager in 1977. In 1981, Mr. Monteen transferred to the North Central Division, serving as the National Emergency Manager in the Emergency Management Office before being appointed Chief, Emergency Management Division in 1982.

He is a member of the American Society of Civil Engineers and the Society of American Military Engineers.

THOMAS C. NUTTLE

Mr. Nuttle is Chief of the Coastal Engineering Section of the US Army Engineer District, Detroit. He has served in this position since 1974, supervising the coastal work in the District, including shore erosion protection and navigation. He joined the Detroit District in 1956 as a hydraulic engineer. Prior to that time he worked with the Buffalo District for 5 years as a civil and hydraulic engineer on the planning and design of hydropower, flood control, reservoir, and navigation projects. Mr. Nuttle received his

B.S. degree from Niagara University, N.Y. in 1949. He served in the US Navy from 1943 to 1946, and in the US Army Reserve from 1949 to 1958. He is a registered professional engineer and a member of the Society of American Military Engineers.

NORBERT F. SCHWARTZ

Mr. Norb Schwartz is presently the Chief of the Natural Hazards Branch at the FEMA Region V office located in downtown Chicago. He manages the National Flood Insurance Program and the Earthquake Program for the six-state region. As the Chief Engineer at FEMA, he was in charge of completing the task of covering the region with Flood Insurance Studies and Flood Insurance Rate Maps. He was also employed at the Chicago Corps of Engineers acting as a Project Engineer for the Chicago Underflow Plan. He received an M.S.degree from the University of Maryland in Civil Engineering/Water Resources. His undergraduate degree is from the University of Michigan.

DONALD L. TOTTEN

Mr. Totten, of Schaumburg, Illinois, was appointed to the International Joint Commission by President Ronald Reagan in July, 1981. He is President of a public relations and management consulting firm. He brings extensive experience to the Commission in legislative work and his background as an engineer. He received his engineering degree from the University of Notre Dame in 1955. He served in the Illinois State Senate (1981-1982) and served four terms in the Illinois House of Representatives (1973-1980). Mr. Totten served on the appropriations, higher education, and election committees.

Before his legislative career, Mr. Totten was assistant to the Director of the Department of Transportation for the State of Illinois for 2 1/2 years. Prior to that, he spent 15 years in the engineering and business fields.

Mr. Totten was elected Republican party Chairman of Schaumburg Township in 1966 and reelected four times. In 1976 he was State Chairman of the Illinois Citizens for Reagan and a member of the Steering Committe of the Illinois President Ford Committee. He served as regional political director for the

Reagan for President Committee in Illinois in 1980. Presently, Mr. Totten is Chairman of the Cook County Republican Party.

DR. C. LINWOOD VINCENT

Dr. Vincent is currently Senior Scientist and Program Manager for the four Coastal Engineering Research Programs at the Coastal Engineering Research Center (CERC), Waterways Experiment Station (WES). His positions in the past include Chief, Coastal Branch, Wave Dynamics Division, Hydraulics Laboratory, WES; Chief, Coastal Oceanography Branch, Research Division, CERC, Ft. Belvoir, VA; and Senior Scientist, Research Division, CERC, WES. Dr. Vincent's research interests include ocean wave mechanics, air-sea interaction, spectral wave modeling, and wave climatology. He has also worked in the area of tidal inlet processes. Dr. Vincent has received an Army Research and Development Achievement Award and The American Society of Civil Engineers Walter L. Huber Prize for his wave research. Dr. Vincent has a B.A. in Mathematics, an M.S. and Ph.D. in Environmental Sciences (Earth Sciences) from the University of Virginia.

RONALD E. WILSHAW

Mr. Wilshaw came to the United States from Canada in 1954. He graduated from Wayne State University with a B.S. degree in civil engineering in 1958 and an M.S. in civil engineering in 1963. He joined the US Army Corps of Engineers in 1964 and is presently the Chief of the Great Lakes Hydraulics and Hydrology Branch. He is a registered professional engineer in Michigan and a member of S.A.M.E. He is currently the US secretary on the coordinating committee on Great Lakes Basic Hydraulic and Hydrologic Data, a US member on the working committee of the International Niagara Board of Control, and alternate US regulation representative on the International Lake Superior Board of Control.

DR. WILLIAM L. WOOD

Dr. Wood is Director of the Great Lakes Coastal Research Laboratory and a Professor of Ocean Science and Engineering at Purdue University. He received his B.S. degree in mathematics and physics from Michigan State University and his Ph.D. in geophysics from Michigan State University. Dr. Wood's research is focused on coastal hydrodynamics, sediment transport, boundary layer processes, and large lake dynamics. Dr. Wood is a member of a number of professional and honor societies and currently serves on the National Research Council's Committee on Coastal Engineering Measurement and chairs the NRC's Committee on Coastal Erosion Zone Management. Author of numerous professional publications, Dr. Wood is currently completing a book in the series Living With America's Coastlines: Lake Michigan's Coast.

APPENDIX B:
RECOMMENDATION LETTERS FROM CERB MEMBERS

UNIVERSITY OF Miami

May 23, 1988

B. G. Patrick J. Kelly
U.S. Army Corps of Engineers
20 Massachusetts Avenue, N.W.
Washington, D.C.

Dear General Kelly:

I thank you very much for the honors which have been conferred upon me for my service as a member of CERC. During those six years, I have had the satisfaction of witnessing the creation of a new CERC. At the beginning we only had hope, but we have seen our expectations materialize. I have a great satisfaction to have been able to participate in our common effort.

However, the credit has to go to all CERC researchers whose hard work have made CERC a more efficient and prestigious place. Needless to say, the tasks are not finished, and I have as a board member a last word of recommendation - our next efforts would be to modernize our experimental facility with unique facilities with new equipment, new installations with nonintruding sensors. I know that in time of budget cuts this demand may be illusory. On a longterm I count on an awakening of public awareness and a resurgence of public works, and particularly coastal work, corresponding to the real needs of our society.

I will certainly remain in touch with the Corps through many channels. It has been an honor for me and a pleasure to serve a group of such dedicated professionals.

Sincerely yours,

Bernard Le Mehaute
Professor
Applied Marine Physics

cc: J. Houston,
CERC-WES

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June 17, 1988

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General Patrick J. Kelley
Acting President CERB
Commander US Army Engineering Division
South Pacific
630 Sansome Street, Room 720
San Fransisco, CA 94111–2206

Dear General Kelley:

In the 49th meeting of CERB, the theme on Coastal Engineering in the Great Lake Regions was thoroughly covered indeed. It is gratifying to learn that the tasks of the N.E. Division are far–ranging and are always carried out with the active participation of the local communities.

May I reiterate the comments made about the Graduate School of Coastal Engineering? The proposed joint programs of MS in Coastal Engineering between CERC and Texas A&M, and between CERC and U. of Louisiana are brilliantly conceived in general outlook and in details. The gap that exists between university programs and the tasks facing the practice of engineering inside and outside the Corps is well recognized. The proposed programs are certainly a significant step towards filling this gap. All those involved deserve our hearty congratulations.

As is felt by many at the CERB meeting, the idea of broadening the program is appealing indeed. I especially wish to support the following measures which may already be on the planners' minds:

(1) Invite additional U.S. universities to propose similar joint ventures with CERC;
(2) Offer the program every year;
(3) Open to U.S. and foreign students outside the Corps.

In the plan presently proposed, the immediate advantage is obviously that Corps Engineers can receive advanced training in the coastal engineering specialty. With further broadening, the following advantages can be foreseen in addition:

(1) More U.S. engineers can be attracted to the Corps;
(2) More foreign engineers will become familiar with the capabilities of CERC. This can only help in the future privatization of CERC;
(3) With more participants it is easier to offer the program every year.

Because they provide direct links, so far meager, between academia and practice, such programs use optimally the existing expertise and stimulate further growth in the universities as well as CERC. This can only lead to farther progress of the science and practice of coastal engineering.

As a matter of details, I also think that for students who are not Corps Engineers, the one–year limit should be relaxed. In most universities where a thesis is required, the normal residence is one to two years.

Looking forward to the next CERB meeting.

Sincerely yours,

Chiang C. Mei
Professor of Civil Engineering
Member CERB

cc: Col. Dwayne Lee
Ms. Sharon Hanks
Dr. J. Houston

Department of Geology and Geophysics
LOUISIANA STATE UNIVERSITY AND AGRICULTURAL AND MECHANICAL COLLEGE
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May 23, 1988

Brigadier General Patrick J. Kelly
President, Coastal Engineering Research Board
US Army Engineer Division, South Pacific
630 Sansome Street, Room 720
San Francisco, CA 94111-2206

Dear General Kelly:

As expected, the 49th meeting of the Coastal Engineering Research Board provided a well-organized, informative and stimulating discussion of issues pertinent to the shores of America's Great Lakes. The theme focus proved again to be a suitable format for these meetings.

The reduced water levels of the Great Lakes make the concerns about shoreline erosion less urgent, yet it is clear that further retreat of the shore is inevitable. Moreover, because well-designed research programs are difficult to implement in a crisis atmosphere, the present period of relief from more "political" pressure should be effectively used to stimulate basic research on Great Lakes coastal processes. It was, therefore, particularly pleasing to see the present efforts by CERC and the region's universities to organize the Great Lakes 88 and 89 field experiments. I would urge the Corps to give these experiments their strongest possible logistical and financial support. The clear success of past cooperative programs between CERC and national research universities, such as the experiments at Duck, North Carolina, have demonstrated the value of continued collaboration of this kind.

Based on the technical program review held at CERC in early May and this Board meeting it is clear that CERC's research program is strong, creative and well focused on problems of direct relevance to the mission of the Army Corps of Engineers. The new leadership, including director Dr. James Houston and program manager Dr. Linwood Vincent, are performing a great job in creating an organization which is both increasingly responsive to the needs of the districts and the challenges of long-term research.

It is clear from many comments at the 49th CERB meeting that a disturbing attitude is developing among some district personnel that nothing can be done regarding many coastal problems until new numerical models have been developed. While I am as much in favor of numerical modeling as anyone, care should be taken not to use the absence of a model as an excuse for sloppy engineering. We have learned a lot about coastal processes over the past 30 years before the major advances in numerical modeling. This disciplinary knowledge, combined with common sense, is available and should be used in current projects. District personnel should not abandon their own sound engineering judgment in the process of waiting for a new numerical model to come on line.

This brings me to my final point: the educational process. It is very important to the success of a Corps project that personnel involved in its design are fully cognizant about the state-of-the-art in the relevant discipline. In many cases much of this relevant knowledge resides outside the Corps. Although CERC is doing a good job incorporating such knowledge in their research program I see little evidence that the districts make similar efforts. The "Prospect" course series, sponsored by the Huntsville Division of the Corps is a good beginning and should be expanded. However, successful integration of new knowledge in coastal engineering, irrespective of where it is generated, will also require more initiative on the part of individual district commanders to encourage technical personnel (coastal specialists) to continuously enhance their own education by formal and informal means.

It was a pleasure seeing you and the other board members again at Oconomowoc this past week and I look forward to our next meeting in Norfolk and a discussion of "long-term" research objectives.

Sincerely Yours,

Dag Nummedal

Dag Nummedal
Professor of Geology
Member, Coastal Engineering Research Board

DN/jeb

cc. James R. Houston, CERC
Col. Dwayne G. Lee, Cmdr. WES